Application for Incidental Harassment Authorization for the Non-Lethal Taking of Whales and Seals in Conjunction with a Planned Ice Overflight Survey Program in the Chukchi and Beaufort Seas, Alaska May 2015 – April 2016

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Prepared by:

Shell Gulf of Mexico Inc.
Shell Offshore Inc.
3601 C Street, Suite 1000
Anchorage, Alaska 99503

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ATTACHMENTS

Attachment A Chukchi and Beaufort Sea Ice Overflight Survey Program Marine Mammal Monitoring and Mitigation Plan (4MP)

Attachment B Chukchi Sea Plan of Cooperation (POC)

EXECUTIVE SUMMARY

Shell Gulf of Mexico Inc. and Shell Offshore Inc., collectively (Shell) plans to conduct ice overflight surveys during freeze-up, winter, and break-up periods in 2015 and 2016 to gather additional data on ice conditions in select areas of the Chukchi and Beaufort Seas. Ice surveys characterize ice thickness, type, and movement during the fall, winter and spring seasons as well as identify locations of possible strudel scour events.

The ice overflight surveys planned by Shell are industry-standard, scientific surveys. These surveys typically result in continuous sound emitted from the aircraft as it travels through an area, which could result in exposure to sounds that may result in takes of marine mammals protected under the Marine Mammal Protection Act (MMPA).

In order for NMFS to consider authorizing the taking of small numbers of marine mammals incidental to the ice overflight surveys program, or to make a finding that incidental take is unlikely to occur, the operator must submit a written request or application. The organization of this request by Shell for an Incidental Harassment Authorization (IHA) for the ice survey program follows the organization of 50 Code of Federal Regulations (CFR) § 216.104 (a). The remainder of this document is organized as to follow 50 CFR § 216.104 (a) (1)-(14). Shell used the following guidance to prepare its request for IHA, or IHA application (IHAA).

50 CFR § 216.104 "Submission of Requests"

(a) In order for the National Marine Fisheries Service (NMFS) to consider authorizing the taking by U.S. citizens of small numbers of marine mammals incidental to a specified activity (other than commercial fishing), or to make a finding that incidental take is unlikely to occur, a written request must be submitted to the Assistant Administrator. All requests must include the following information for their activity.

Shell has estimated the exposures of marine mammals that may result from the overflight activity using the best available understanding of marine mammal densities and presence in the Chukchi and Beaufort Seas. These estimates indicate that only small numbers of marine mammals could be exposed to sound from the overflight surveys. Any take by Level B harassment is expected to have a negligible impact on affected marine mammal species or stocks and would not have an un-mitigable adverse impact on the taking of species or stocks for subsistence uses.

1. DESCRIPTION OF SPECIFIED ACTIVITY

Shell plans to conduct two periods of ice overflight surveys during May 2015 - April 30, 2016

(Figure 1-1):

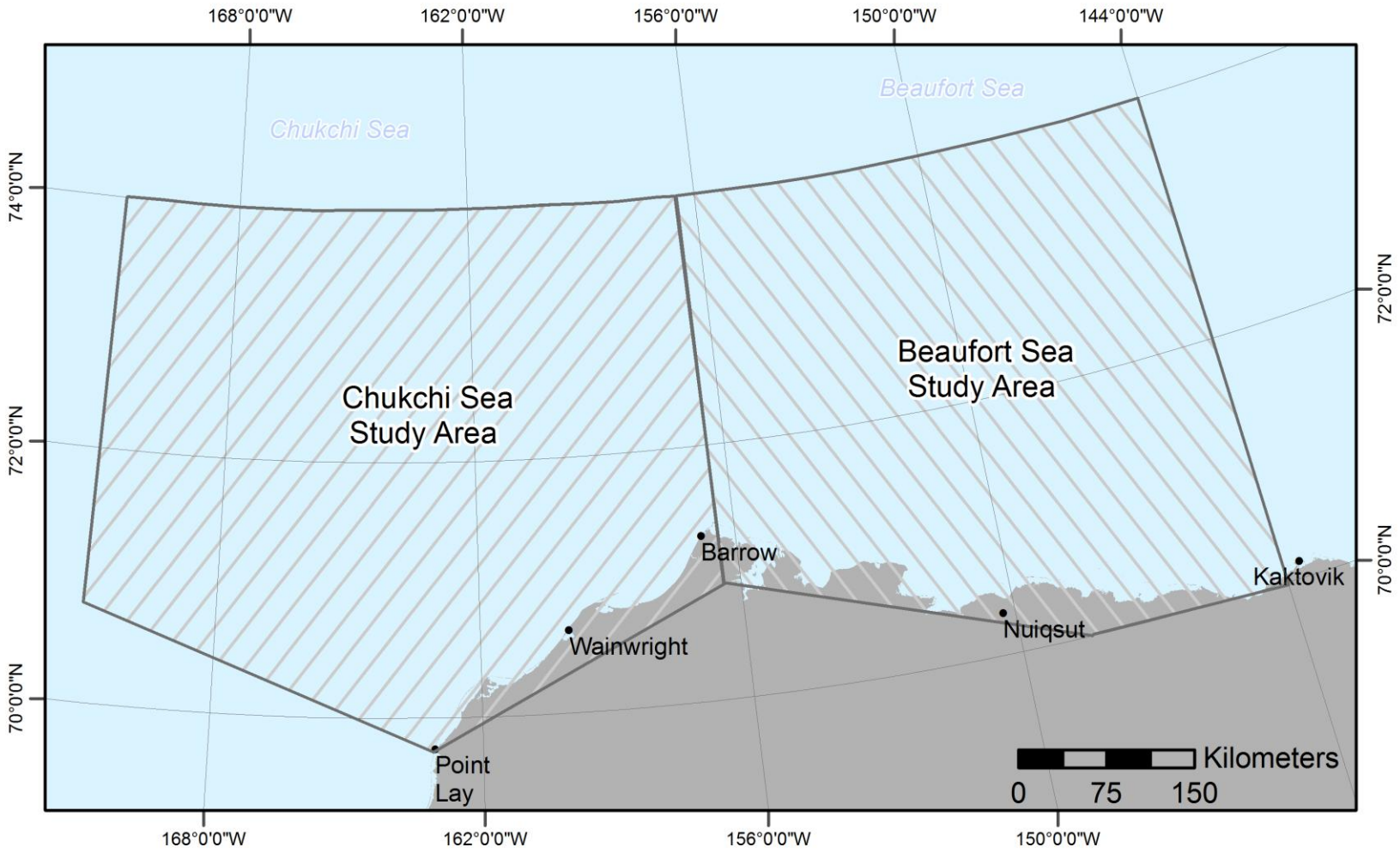
- Break-up Surveys
- Freeze-up Surveys

Shell plans to conduct the overflight surveys from fixed wing and rotary aircraft. The aircraft to be used for the surveys are not currently under contract to Shell, or a contractor to Shell. The proposed aircraft types for overflight surveys are discussed later in this section.

Ice and weather conditions will influence when and where the surveys can be conducted. For initial planning purposes, Shell proposes to conduct the overflight surveys during May 2015 - April 30, 2016. Estimated timeframes within the May to April period for the surveys are discussed in Section 2 of this IHAA.

Aircraft supporting these surveys will operate out of Barrow and Deadhorse.

Figure 1-1 Location Map for Break-Up and Freeze-Up Overflight Surveys



Proposed Break-Up Surveys

The break-up surveys will occur between June and July in either the Chukchi or Beaufort Sea and will include:

- Up to five fixed-wing flights of approximately 1,500 nm total for up to approximately 13 hours total;
- One helicopter flight totaling of approximately 200 nm total for up to approximately 3 hours total.

Flight altitudes for fixed wing surveys will mostly be at or above 152 m (500 ft.) and range from 30 to 610 m (100 to 2,000 ft.). For helicopter flights, the altitude will mostly be at or above 61 m (200 ft.) with a range of 15 to 152 m (50 to 500 ft.). Flights will occur when there is daylight and aircraft are not scheduled to fly at the same time.

Proposed Freeze-Up Surveys

The freeze-up surveys will occur between November 2015 - March 2016 in either the Chukchi or Beaufort Sea and will include:

- Up to seven fixed-wing flights of approximately 2,500 nautical miles (nm) total in early winter for up to approximately 21 hours total;
- One helicopter flight in the Beaufort of approximately 200 nm that will include approximately 4 landings to collect ice measurements during late freeze-up including sampling with a battery powered ice auger for up to approximately 3 hours total.

Flight altitudes for fixed wing surveys will mostly be at or above 152 m (500 ft.) and range from 30 to 610 m (100 to 2,000 ft.). For helicopter flights, the altitude will mostly be at or above 61 m (200 ft.) with a range of 15 to 152 m (50 to 500 ft.) and will also include landings. Flights will occur when there is daylight and aircraft are not scheduled to fly at the same time. Proposed Aircraft to Conduct Ice Overflight Surveys

Shell plans to conduct the ice overflight surveys with an Aero Commander (or similar) fixed winged aircraft and a Bell 412, AW 139, EC 145 (or similar) helicopter.

Shell will also have a dedicated helicopter for Search and Rescue (SAR) for the spring 2015 surveys. The SAR helicopter is expected to be a Sikorsky S-92 (or similar). This aircraft will stay grounded at the Barrow shorebase location except during training drills, emergencies, and other non-routine events.

2. DATES AND DURATION, SPECIFIED GEOGRAPHIC REGION

Dates and Duration of Activities that this Application is Proposed to Cover

Shell requests that the IHA covers the period of planned operations for the 2015/2016 ice overflight surveys from May 1, 2015 thru April 30th, 2016.

Specific Geographic Region Where the Activities will Occur

The planned ice overflight surveys will occur in the Chukchi and Beaufort Seas in the general areas identified in Figures 1-1 to 1-3 and will be subsequently referred to as the Project Area.

3. SPECIES AND NUMBERS OF MARINE MAMMALS

Marine mammals that occur in the activity area of the planned ice overflight surveys in the Alaskan Chukchi and Beaufort Seas belong to three taxonomic groups: odontocetes (toothed cetaceans, such as beluga whale), mysticetes (baleen whales), and carnivora (pinnipeds and polar bears). The majority of flight activity will be conducted either during winter when nearly 10/10 ice coverage is present, or during spring when sea ice also pre-dominates the study area. Flight time over open water and adjacent ice edges will be limited as a mitigation measure to minimize the potential disturbance of cetaceans. This and other mitigation measures are described in greater detail in Sections 8, 11, and 12. The Pacific walrus and polar bear are managed by the U.S. Fish & Wildlife Service (USFWS) and are not discussed further in this application. Of the marine mammal species included in this application, seals hauled out on ice are the most likely to be encountered and potentially disturbed incidental to the ice overflight program of activities.

Several marine mammal species that occur in the ice overflight activity area have been listed as either "threatened" or "endangered" under the Endangered Species Act (ESA). Bowhead, humpback, and fin whales are listed as endangered; however, cetaceans are unlikely to be encountered in large numbers due to the over-ice priority and timing of surveys primarily during winter when the majority of cetaceans are absent from the Chukchi and Beaufort Seas.

Ringed seal, which is the most likely species to be encountered during ice overflights, has recently been listed as threatened species under ESA (NMFS 2012a). Bearded seal was listed by NMFS as threatened at the same time (NMFS 2012b), however, on July 25, 2014 the U.S. District Court for the District of Alaska vacated the listing rule with respect to the Beringia bearded seal distinct population segment (DPS) and remanded the rule to NMFS to correct the deficiencies identified in the opinion. The Beringia DPS is not considered a listed species (identified as "Candidate" in Table 4-1). The listing is still in effect for the Okhotsk DPS (which is located in the Okhotsk Sea off the coast of Russia), but the Okhotsk DPS is not subject to potential exposure from the activities described in this IHAA. Both ringed seals and bearded seals are likely to be encountered during the ice overflight surveys.

To avoid redundancy, we have included the required information about the species that are known to or may be present in the area where surveys will be taking place below in Section 4.

4. AFFECTED SPECIES STATUS AND DISTRIBUTION

Sections 3 and 4 are integrated here to minimize repetition.

The ringed and bearded seals are the two marine mammal species under NMFS jurisdiction, most likely to be encountered in ice-covered regions during the planned ice overflights in the Chukchi and Beaufort Seas. The species most likely to be encountered widely (in space and time) through-out the period of the proposed ice overflights is the ringed seal. Although bearded seals, spotted seals, and ribbon seals typically migrate south in the fall, it is possible that small numbers of these seals may be present in the survey area, particularly as they return in the spring. Nine cetacean species; beluga whale, bowhead whale, narwhal, killer whale, harbor porpoise, gray whale, minke whale, fin whale, and humpback whale could occur in the project area; however, occurrence of these species is unlikely to be encountered frequently due to the timing of overflights primarily during winter. Additionally, cetaceans would only be present and have the potential to be disturbed, during the minimal time spent flying over open water and adjacent ice edges.

Reliable population estimates for many species of marine mammals found in the activity area are not available. All of the marine mammal species found in the activity area belong to populations that exist in regions outside the Chukchi Sea at some point during their life histories. In many cases, population estimates exist for a species or stock, but they are not specific to the activity area itself. The best available and relevant population information for each species found in the activity area is summarized below in Table 4-1, including habitat, abundance estimate (and origin), and conservation status.

Table 4-1 The Habitat, Abundance, and Conservation Status of Marine Mammals Inhabiting the Area

Species	Habitat	Abundance	ESA[1]	IUCN[2]	CITES[3]
Odontocetes					
Beluga whale (*Delphinapterus leucas*) (Eastern Chukchi Sea Stock)	Offshore, Coastal, Ice edges	3,710[4]	Not listed	NT	–
Beluga whale (Beaufort Sea Stock)	Offshore, Coastal, Ice edges	39,258[5]	Not listed	NT	–
Narwhal (*Monodon monoceros*)	Offshore, Ice edge	Rare[6]	Not listed	NT	–
Killer whale (*Orcinus orca*)	Widely distributed	Uncommon	Not listed	DD	–
Harbor Porpoise (*Phocoena phocoena*) (Bering Sea Stock)	Coastal, inland waters, shallow offshore waters	48,215[4] Common[7]	Not listed	LC	–
Mysticetes					
Bowhead whale (*Balaena mysticetus*)	Pack ice, coastal	10,545[8] 16,892[9]	Endangered	LC	I
Gray whale (*Eschrichtius robustus*) (Eastern Pacific population)	Coastal, lagoons, shallow offshore waters	19,126[10]	Not listed	LC	I
Minke whale (*Balaenoptera acutorostrata*)	Shelf, coastal	Rare	Not listed	LC	I
Fin whale (*Balaenoptera physalus*)	Slope, mostly pelagic	Rare	Endangered	EN	I
Humpback whale (*Megaptera novaeangliae*)	Shelf, coastal	Rare	Endangered	LC	I
Pinnipeds					
Bearded seal (*Erignathus barbatus*)	Pack ice, shallow offshore waters	155,000[11]	Candidate[16]	LC	–
Spotted seal (*Phoca largha*)	Pack ice, coastal haulouts, offshore	~141,479[12]	Arctic pop. segments not listed	DD	–
Ringed seal (*Pusa hispida*)	Landfast & pack ice, offshore	~208,000-252,000[13]	Threatened	LC	–
Ribbon seal (*Histriophoca fasciata*)	Pack ice, offshore	90-100,000[14] 49,000[15]	Not Listed	DD	–

[1] U.S. Endangered Species Act.
[2] Red List of Threatened Species (IUCN 2013). Codes for IUCN classifications: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; DD = Data Deficient
[3] Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2013)
[4] Allen and Angliss (2014)
[5] Beaufort Sea populations (Allen and Angliss 2014)
[6] Population in Baffin Bay and the Canadian arctic archipelago is ~60,000 (DFO 2010); very few in Alaska (Allen and Angliss 2014)
[7] Vessel-based observations from Industry activities in 2006–2010 (Hartin et al. 2013)
[8] 2001 B-C-B Bowhead population estimate (Zeh and Punt 2005)
[9] 2011 B-C-B Bowhead population estimate (Givens et al. 2013)
[10] North Pacific gray whale population (Laake et al. 2009)
[11] Beringia Distinct Population Segment (Cameron et al. 2010)
[12] Central and Eastern Bering Sea stock based on aerial surveys in 2007 (Allen and Angliss 2014)
[13] Eastern Chukchi Sea population (Bengtson et al. 2005)
[14] Bering Sea, (Burns 1981a)
[15] Eastern and Central Bering Sea (Allen and Angliss 2014)
[16] On July 25, 2014 the U.S. 9th district court vacated the listing rule with respect to the Beringia bearded seal DPS and remanded the rule to NMFS to correct the deficiencies identified in the opinion. The Beringia DPS is not listed (identified as "Candidate"), but the listing is still in effect for the Okhotsk DPS (which is located in the Okhotsk Sea off the coast of Russia).

Odontocetes

(a) Beluga (Delphinapterus leucas)

The beluga whale is an arctic and subarctic species that includes several populations in Alaska and northern European waters. In Alaska, beluga whales comprise five distinct stocks: Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea, Bristol Bay, and Cook Inlet (O'Corry-Crowe et al. 1997). Some eastern Chukchi Sea animals enter the Beaufort Sea in late summer (Suydam et al. 2005). For the proposed project, only animals from the Beaufort Sea stock and eastern Chukchi Sea stock may be encountered.

The Beaufort Sea population was estimated to contain 39,258 individuals as of 1992 (Allen and Angliss 2014). Beluga whales of the Beaufort stock winter in the Bering Sea, summer in the eastern Beaufort Sea, and migrate in offshore waters of western and northern Alaska (Allen and Angliss 2014). The majority of belugas in the Beaufort stock migrate into the Beaufort Sea in April or May, although some whales may pass Point Barrow as early as late March and as late as July (Braham et al. 1984; Ljungblad et al. 1984; Richardson et al. 1995a).

The most recent estimate of the eastern Chukchi Sea population is 3710 animals (Allen and Angliss 2014). This estimate was based on surveys conducted in 1989–1991. Survey effort was concentrated on the 170-km long Kasegaluk Lagoon where belugas are known to occur during the open-water season. The actual number of beluga whales recorded during the surveys was much lower. Correction factors to account for animals that were underwater and for the proportion of newborns and yearlings that were not observed due to their small size and dark coloration were used to calculate the estimate. The calculation was considered to be a minimum population estimate for the eastern Chukchi Sea stock because the surveys on which it was based did not include offshore areas where belugas are also likely to occur. This population is considered to be stable. It is assumed that beluga whales from the eastern Chukchi stock winter in the Bering Sea (Allen and Angliss 2014).

Belugas may be encountered during spring ice overflight surveys as they migrate into the Chukchi and Beaufort Seas in April or May, although preferred habitat along ice edges and in polynya zones will be avoided during survey activities.

(b) Narwhal (Monodon Monoceros)

Narwhals have a discontinuous arctic distribution (Hay and Mansfield 1989; Reeves et al. 2002). A large population inhabits Baffin Bay, West Greenland, and the eastern part of the Canadian Arctic archipelago, and much smaller numbers inhabit the Northeast Atlantic/East Greenland area. Population estimates for the narwhal are scarce, and the IUCN-World Conservation Union lists the species as Data Deficient (IUCN 2008). Innes et al. (2002) estimated a population size of 45,358 narwhals in the Canadian Arctic although little of the area was surveyed. There are scattered records of narwhals in Alaskan waters where the species is considered extralimital (Reeves et al. 2002). Thus, it is possible, but unlikely, that individuals could be encountered in the proposed project area.

(c) Killer Whale (*Orcinus orca*)

Killer whales are cosmopolitan and globally fairly abundant. The killer whale is very common in temperate waters, but it also frequents the tropics and waters at high latitudes. Killer whales appear to prefer coastal areas, but are also known to occur in deep water (Dahlheim and Heyning 1999). Killer whales are known to inhabit almost all coastal waters of Alaska, extending from southeast Alaska through the Aleutian Islands to the Bering and Chukchi Seas (Allen and Angliss 2014). Killer whales probably do not occur regularly in the Beaufort Sea, although sightings have been reported (Leatherwood et al. 1986; Lowry et al. 1987). George et al. (1994) reported that they and local hunters see a few killer whales at Point Barrow each year. Killer whales are more common southwest of Barrow in the southern Chukchi Sea and the Bering Sea. Killer whales from either the North Pacific resident or transient stock could occur

in the Chukchi Sea during the summer, however winter occurrence is more unlikely. It is likely that few if any killer whales will be encountered during ice overflight surveys.

(d) Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise is a small odontocete that inhabits shallow coastal waters; temperate, subarctic, and arctic in the Northern Hemisphere (Read 1999). Harbor porpoises occur mainly in shelf areas where they can dive to depths of at least 220 m and stay submerged for more than 5 min (Harwood and Wilson 2001) feeding on small schooling fish (Read 1999). Harbor porpoises typically occur in small groups of only a few individuals and tend to avoid vessels (Richardson et al. 1995a).

The subspecies *P. p. vomerina* ranges from the Chukchi Sea, Pribilof Islands, Unimak Island, and the south-eastern shore of Bristol Bay south to San Luis Obispo, California. Point Barrow, Alaska, is the approximate northeastern extent of the regular range (Suydam and George 1992), though there are extra-limital records east to the mouth of the Mackenzie River in the Northwest Territories, Canada (LGL Limited, unpubl. data) and recent sightings in the Beaufort Sea in the vicinity of Prudhoe Bay during surveys in 2007 and 2008 (Christie et al. 2010). MMOs onboard industry vessels reported one harbor porpoise sighting in the Beaufort Sea in 2006 and no sightings were recorded in 2007 or 2008 (Savarese et al. 2010). Monnett and Treacy (2005) did not report any harbor porpoise sightings during aerial surveys in the Beaufort Sea from 2002 through 2004. Suydam and George (1992) suggested that harbor porpoises occasionally occur in the Chukchi Sea and reported nine records of harbor porpoise in the Barrow area in 1985–1991. Harbor porpoises are not expected to be encountered during the ice overflight surveys.

Mysticetes

(a) Bowhead Whale (Balaena mysticetus)

Bowhead whales only occur at high latitudes in the northern hemisphere and have a disjunct circumpolar distribution (Reeves 1980). Bowhead whales are found in four areas: the western Arctic (Bering, Chukchi, and Beaufort Seas) of northeastern Russia, Alaska and northwestern Canada; the Canadian High Arctic and West Greenland (Nunavut, Baffin Bay, Davis Strait, and Hudson Bay); the Okhotsk Sea (eastern Russia); and the Northeast Atlantic from Spitzbergen westward to eastern Greenland. Those four stocks are recognized for management purposes. The largest population is the Western Arctic or Bering–Chukchi–Beaufort (BCB) stock, which includes whales that winter in the Bering Sea, then migrate through the Bering Strait, Chukchi Sea and Alaskan Beaufort Sea to the Canadian Beaufort Sea, where they feed during the summer. These whales migrate west through the Alaskan Beaufort Sea in the fall as they return to wintering areas in the Bering Sea. The BCB bowhead population is currently listed as endangered under the ESA and is classified as a strategic stock by NMFS and depleted under the MMPA (Allen and Angliss 2014).

It is unlikely, but possible that bowhead whales would be encountered in November; as late-migrating bowhead whales transit through the western Beaufort Sea and Chukchi Sea. Recent acoustic and satellite tracking studies suggest that most bowheads will have migrated west of Barrow by mid-October (ADFG 2010). Bowhead whales may be encountered during the spring ice overflight surveys as they migrate through the Chukchi and the western Beaufort Sea through offshore ice leads, generally from March through mid-June (Braham et al. 1984; Moore and Reeves 1993); however, preferred habitat along ice edges and in polynya zones will be avoided during survey activities.

(b) Gray Whale (Eschrichtius robustus)

Gray whales originally inhabited both the North Atlantic and North Pacific oceans. The Atlantic populations are believed to have become extinct by the early 1700s. There are two populations in the North Pacific. A relic population which survives in the Western Pacific summers near Sakhalin Island far from the proposed survey area. The larger eastern Pacific or California gray whale population recovered significantly from commercial whaling during its protection under the ESA until 1994.

Eastern Pacific gray whales calve in the protected waters along the west coast of Baja California and the east coast of the Gulf of California from January to April (Swartz and Jones 1981; Jones and Swartz 1984). At the end of the calving season, most of these gray whales migrate about 8000 km, generally along the west coast of North America, to the main summer feeding grounds in the northern Bering and Chukchi Seas (Tomilin 1957; Rice and Wolman 1971; Braham 1984; Nerini 1984; Moore et al. 2003; Bluhm et al. 2007). The northeastern-most of the recurring feeding areas is in the northeastern Chukchi Sea southwest of Barrow (Clarke et al. 1989). Most gray whales begin southward migration in November with breeding and conception occurring in early December (Rice and Wolman 1971). Gray whales occur fairly often near Point Barrow, but historically only a small number of gray whales have been sighted in the Beaufort Sea east of Point Barrow.

Few gray whales are expected to be encountered during planned ice overflights. Gray whales are not commonly observed in the Beaufort Sea, and it is unlikely that many gray whales will be present in the northern Chukchi Sea during planned surveys in the spring.

(c) Minke Whale (Balaenoptera acutorostrata)

Minke whales have a cosmopolitan distribution at ice-free latitudes (Stewart and Leatherwood 1985), and also occur in some marginal ice areas. The level of minke whale use of the Chukchi Sea is unknown. Leatherwood et al. (1982, *in* Allen and Angliss 2014) indicated that minke whales are not considered abundant in any part of their range, but that some individuals venture north of the Bering Strait in summer. Minke whales have recently been observed in the Chukchi Sea and a few sightings have been reported in the Beaufort Sea. Minke whale sightings are unlikely to occur in the project area during the planned ice overflights.

(d) Fin Whale (Balaenoptera physalus)

Fin whales are widely distributed in all the world's oceans (Gambell 1985), but typically occur in temperate and polar latitudes and less frequently in the tropics (Reeves et al. 2002). The North Pacific population summers from the Chukchi Sea in small numbers to California (Gambell 1985), but does not range into the Alaskan Beaufort Sea or waters of the northern Chukchi Sea.

Fin whales were not recorded during vessel based or aerial surveys in the Beaufort Sea in 2006–2008 (Savarese et al. 2010; Christie et al. 2010), and were not reported during arctic cruises from the *Healy* in 2005 or 2006 (Haley and Ireland 2006; Haley 2006). Fin whales would be unlikely to occur in the project area during the proposed survey period in winter and spring.

(e) Humpback Whale (Megaptera novaeangliae)

Humpback whales are distributed in major oceans worldwide and their range in the North Pacific extends through the Bering Sea into the southern Chukchi Sea (Allen and Angliss 2014). Humpback whales were hunted extensively during the 20th century and worldwide populations may have been reduced to ~10% of their original numbers. The International Whaling Commission banned commercial hunting of humpback whales in the Pacific Ocean in 1965 and humpbacks were listed as endangered under the ESA and depleted under the MMPA in 1973.

Recently there have been numerous sightings of humpback whales in the Chukchi Sea and a single sighting in the Beaufort Sea (Green et al. 2007). Haley et al. (2010) reported four humpback whales during vessel-based surveys in the Chukchi Sea in 2007 and two sightings in 2008. NMML observers recorded a humpback whale during aerial surveys in the Chukchi Sea in 2009 (COMIDA 2009). Green et al. (2007) reported and photographed a humpback whale cow/calf pair east of Barrow near Smith Bay in 2007. Whether the recent humpback whale sightings in the Chukchi and Beaufort Seas are related to climate changes in the Arctic in recent years is unknown. Humpback whales would be unlikely to occur in the proposed project area due to the low numbers that occur in the area and the timing of the survey when humpback whales are typically migrating to and from their breeding and calving grounds in the south.

Pinnipeds

(a) Bearded Seal (*Erignathus barbatus*)

Bearded seals are associated with sea ice and have a circumpolar distribution (Burns 1981b). No reliable estimate of bearded seal abundance is available for the Chukchi Sea (Allen and Angliss 2014). However, Cameron et al. 2010 estimated the Alaska stock of bearded seals to be about 155,000 (Beringia DPS, Cameron et al. 2010) and may consist of 250,000–300,000 individuals (Popov 1976; Burns 1981b). On July 25, 2014 the U.S. District Court for the District of Alaska vacated the listing rule with respect to the Beringia bearded seal DPS and remanded the rule to NMFS to correct the deficiencies identified in the opinion. So for the time being, the Beringia DPS is not listed, but the listing is still in effect for the Okhotsk DPS (which is located in the Okhotsk Sea off the coast of Russia).

The bearded seal is the largest of the northern phocids. They are primarily benthic feeders, preferring a variety of infaunal and epifaunal invertebrates as well as occasional demersal fishes (Bluhm and Gradinger 2008). Bearded seals have occasionally been reported to maintain breathing holes in sea ice; however, in winter and spring they are found primarily in areas with persistent leads or cracks in broken areas within the pack ice, particularly if the water depth is <200 m. Bearded seals apparently also feed on ice-associated organisms when they are present, and this allows a few bearded seals to live in areas considerably more than 200 m deep (Cameron et al. 2009).

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice and to water depth (Kelly 1988). During winter, most bearded seals in Alaskan waters are found in the Bering Sea. In the Chukchi and Beaufort Seas, favorable conditions are more limited, and consequently, bearded seals are less abundant there during winter (MacIntyre and Stafford, 2011); although they have occasionally been reported to maintain breathing holes in sea ice and broken areas within the pack ice, particularly if the water depth is <200 m (Harwood et al. 2005). From mid-April to June as the ice recedes, some of the bearded seals that overwintered in the Bering Sea migrate northward through the Bering Strait. During the summer they are found near the widely fragmented margin of sea ice covering the continental shelf of the Chukchi Sea and in nearshore areas of the central and western Beaufort Sea.

In some areas, bearded seals are associated with the ice year-round; however, they usually move shoreward into open water areas when the pack ice retreats to areas with water depths greater than 200 m (Cameron et al. 2009). In the Beaufort Sea, suitable habitat is limited because the continental shelf is narrower and the pack ice edge frequently occurs seaward of the shelf and over water too deep for benthic feeding. The preferred habitat in the western and central Beaufort Sea during the open-water period is the continental shelf seaward of the scour zone, although a recent tagging study showed occasional movements of adult bearded seals seaward of the continental shelf (Cameron et al. 2009).

Haley and Ireland (2006) and Haley (2006) also reported much lower percentages of bearded compared to ringed seals during *Healy* cruises in the Arctic. Haley and Ireland (2006) reported only seven bearded seal sightings during an Arctic cruise from the *Healy* in 2005, and 14 bearded seal sightings were reported during the 2006 *Healy* cruise (Haley 2006).

It is unlikely that many bearded seals would be encountered during the proposed ice overflight surveys during winter as most would typically migrate south with the advancing pack ice into the southern Chukchi and Bering Seas. However, some individual seals may remain in the Beaufort and northern Chukchi Seas through the winter and it is possible that some individuals could be encountered during the winter. More bearded seals likely would be encountered in the spring as they migrate northward from the Bering Sea into the Chukchi and Beaufort Seas.

(b) Spotted Seal (*Phoca largha*)

Spotted seals (also known as largha seals) occur in the Beaufort, Chukchi, Bering, and Okhotsk Seas, and south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay 1977). They migrate south from the Chukchi Sea and through the Bering Sea in October (Lowry et al. 1998). Spotted seals overwinter in the Bering Sea and inhabit the southern margin of the ice during spring (Shaughnessy and Fay 1977).

An early estimate of the size of the world population of spotted seals was 370,000–420,000, and the size of the Bering Sea population, including animals in Russian waters, was estimated to be 200,000–250,000 animals (Bigg 1981). During the summer, spotted seals are found in Alaska from Bristol Bay through western Alaska to the Chukchi and Beaufort Seas. The total number of spotted seals in Alaskan waters is not known (Allen and Angliss 2014), but based on aerial surveys conducted in 2007, Allen and Angliss (2013) estimate the Alaskan population at 141,479 animals. The Alaska stock of spotted seals is not classified as endangered, threatened, or as a strategic stock by NMFS (Allen and Angliss 2014); although the southern distinct population segment of spotted seals was recently listed as a threatened species, it occurs entirely outside of U.S. waters.

During spring when pupping, breeding, and molting occur, spotted seals are found along the southern edge of the sea ice in the Okhotsk and Bering Seas (Quakenbush 1988; Rugh et al. 1997). In late April and early May, adult spotted seals are often seen on the ice in female-pup or male-female pairs, or in male-female-pup triads. Subadults may be seen in larger groups of up to 200 animals. During the summer, spotted seals are found primarily in the Bering and Chukchi Seas, but some range into the Beaufort Sea (Rugh et al. 1997; Lowry et al. 1998) from July until September. At this time of year, spotted seals haul out on land part of the time, but also spend extended periods at sea. Spotted seals are commonly seen in bays, lagoons and estuaries, but also range far offshore and as far north as 69–72ºN latitude. In summer, they are rarely seen on the pack ice, except when the ice is very near shore. As the ice cover thickens with the onset of winter, spotted seals leave the northern portions of their range and move into the Bering Sea (Lowry et al. 1998).

In the Chukchi Sea, Kasegaluk Lagoon and Icy Cape are important areas for spotted seals. Spotted seals haul out in this region from mid-July until freeze-up in late October or November. Lowry et al. (1998) reported a maximum count of about 2,200 spotted seals in the lagoon during aerial surveys. No spotted seals were recorded along the shore south of Pt. Lay. Based on satellite tracking data, Frost et al. (1993) reported that spotted seals tagged at Kasegaluk Lagoon spent 94 percent of the time at sea. Extrapolating the count of hauled-out seals to account for seals at sea would suggest a Chukchi Sea population of about 36,000 animals.

The Chukchi Sea Environmental Studies Program (CSESP) vessel-based surveys from 2008–2012 recorded 217 spotted seals as well as 756 seals that could not be identified as either ringed or spotted seals (Aerts et al. 2013). Observers aboard industry vessels operating in the Chukchi Sea from 2008–2010 reported 288 sightings of 355 individual spotted seals (Hartin et al. 2013). Some of the 2,035 unidentified seals recorded during those years were likely spotted seals as well.

Relatively low numbers of spotted seals are present in the Beaufort Sea. A small number of spotted seal haulouts are (or were) located in the central Beaufort Sea in the deltas of the Colville River and previously the Sagavanirktok River. Historically, these sites supported as many as 400–600 spotted seals,

but in the 1990s <20 were seen at any one site (Johnson et al. 1999). A total of 12 spotted seals were positively identified near the source vessel during open-water seismic programs in the central Alaskan Beaufort Sea during the 6 years from 1996 to 2001 (Moulton and Lawson 2002, p. 317). Numbers seen per year ranged from zero (in 1998 and 2000) to four (in 1999). More recently Green et al. (2007) reported 46 spotted seal sightings during barge operations between West Dock and Cape Simpson. Most sightings occurred from western Harrison Bay to Cape Simpson with only one sighting offshore of the Colville River delta. No spotted seals were identified from the *Healy* during arctic cruises in 2005 or 2006 (Haley and Ireland 2006; Haley 2006).

Spotted seals leave the northern portions of their range with the onset of winter and move into the Bering Sea (Lowry et al. 1998). It is therefore unlikely that spotted seals would be encountered during the proposed ice overflight surveys until spring when they begin migrating northward from the Bering Sea into the Chukchi and Beaufort Seas.

(c) Ringed Seal (Phoca hispida)

Ringed seals have a circumpolar distribution and occur in all seas of the Arctic Ocean (King 1983). They are closely associated with ice and, in the summer, they often occur along the receding ice edges or farther north in the pack ice. In the North Pacific, they occur in the southern Bering Sea and range south to the seas of Okhotsk and Japan. They are found throughout the Beaufort, Chukchi, and Bering Seas (Allen and Angliss 2014). The Alaska stock, part of the Arctic subspecies of ringed seal, has been listed as threatened under the ESA (NMFS 2012b).

Ringed seals are year-round residents in the Chukchi and Beaufort Seas and the ringed seal is the most frequently encountered seal species in the area. During winter, ringed seals occupy landfast ice and offshore pack ice of the Bering, Chukchi, and Beaufort Seas. In winter and spring, the highest densities of ringed seals are found on stable shorefast ice. However, in some areas where there is limited fast ice but wide expanses of pack ice, including the Beaufort and Chukchi Seas and Baffin Bay, total numbers of ringed seals on pack ice may exceed those on shorefast ice (Burns 1970, Stirling et al. 1982, Finley et al. 1983). Adult ringed seals maintain breathing holes in the ice and occupy lairs in accumulated snow (Smith and Stirling 1975) while some subadult ringed seals appear to winter near the pack-ice edge in the Bering Sea (Crawford et al. 2012). They give birth in lairs from mid-March through April, nurse their pups in the lairs for 5–8 weeks, and mate in late April and May (Smith 1973, Hammill et al. 1991, Lydersen and Hammill 1993).

Frost et al. (2004) report ringed seal densities during aerial surveys in the central Alaskan Beaufort Sea during late May and early June 1996–1999 were highest in water depths between 5 and 35 m. Densities were also highest in relatively flat ice and near the fast ice edge, declining both shoreward and seaward of that edge (Frost et al 2004). Seal distribution and density in late May and early June, prior to break-up, are thought to reflect distribution patterns established earlier in the year. Higher abundance could indicate greater prey availability during fall and winter, when seals are actively feeding and when breathing holes are established (Frost et al. 2004). During late fall and winter, a seasonal shift in the ringed seal diet from hyperiid amphipods to arctic cod occurs in the central Beaufort Sea (Lowry et al. 1980; Bluhm and Gradinger 2008). During November–February, Arctic cod occur in nearshore areas and spawn (Craig et al. 1984), and this ephemeral prey resource may attract ringed seals.

The availability of sea ice habitat used by ringed seals varies on short (daily and weekly) as well as long (annual and decadal) time scales. Weather at the time of freeze-up and throughout the winter affects the ice roughness and snow cover, which in turn determine the suitability of ice as ringed seal habitat. Even within the same season, snow and ice conditions may change drastically within just a few days. This is particularly true along the coastlines of Alaska, where fast ice occurs as an unprotected, linear band that abuts the pack ice and may be heavily impacted by storms and ocean currents. This variability makes among-year comparisons along the Alaska coast very difficult (Frost et al. 1988).

Ringed seal will likely be the most abundant species of ice seal encountered throughout the winter and spring in the Chukchi and Beaufort Seas during ice overflight surveys.

(d) Ribbon Seal (Histriophoca fasciata)

Ribbon seals are found along the pack-ice margin in the southern Bering Sea during late winter and early spring and they move north as the pack ice recedes during late spring to early summer (Burns 1970, Burns et al. 1981a). Little is known about their summer and fall distribution, but Kelly (1988) suggested that they move into the southern Chukchi Sea, based on a review of sightings during the summer. During a recent satellite telemetry program sponsored by the NMML, a number of ribbon seals tagged in the Bering Sea in May had moved to the Chukchi Sea by July (NMML 2009). However, ribbon seals appeared to be relatively rare in the northern Chukchi Sea during recent vessel-based surveys. From 2006–2012, there were only nine ribbon seal sightings among the total of 3,443 seal sightings identified to species from industry sponsored vessels (LGL et al. 2013). CSESP vessel-based observers recorded six animals in 2008, none in 2009 and 2010, two in 2011, and none in 2012 (Aerts et al. 2013). Ribbon seals do not normally occur in the Beaufort Sea; however, three recent ribbon seal sightings were reported during vessel-based activities in the Beaufort Sea in 2008 (Savarese et al. 2010).

In response to a petition to list the ribbon seal under the Endangered Species Act (CBD 2007) NMFS concluded that listing of the ribbon seal was not warranted at this time (NMFS 2008). Ribbon seals would be unlikely to occur in the proposed ice overflight project area in winter but could be encountered infrequently during flights in the spring.

5. TYPE OF INCIDENTAL TAKING AUTHORIZATION REQUESTED

Shell requests an IHA pursuant to Section 101(a)(5)(D) of the MMPA for incidental take, by Level B harassment only, of small numbers of cetaceans and seals during its planned ice overflights in the Chukchi and Beaufort Seas during May 2015 - April 30th 2016.

The effect will depend on the behavior of the animal at the time of reception of the stimulus, as well as the distance from the aircraft and received level of sound. Cetaceans will only be present, and thus have the potential to be disturbed, when aircraft fly over open water in between ice floes; seals may be disturbed when aircraft are over open water or over ice on which seals may be present. Disturbance reactions are likely to vary among some of the seals in the general vicinity, and not all of the seals present are expected to react to fixed wing aircraft and helicopters.

In light of the nature of the activities, and for the reasons described below, we do not expect marine mammals will be injured or killed as a result of ice overflight surveys. Shell's proposed ice overflight survey is likely to result in impacts that are similar to those considered by NMFS in its 2011 MMPA IHA issued to the U.S. Fish and Wildlife Service for its polar bear capture/recapture program. See 76 Fed. Reg. 13130 (March 11, 2011).

Of the seal species which may be encountered, only ringed seals are abundant in the Chukchi and Beaufort Seas during the winter and early spring when the overflights are scheduled to occur. In March-April, ringed seals give birth in subnivean lairs established on shorefast and stable pack ice (Smith and Stirling 1975; Smith 1973). Ringed seals in subnivean layers have been known to react to aircraft overhead by entering the water in some instances (Kelly et al. 1986); however, there is no evidence to indicate injurious effects to adults or pups from such a response.

Bearded seals spend the winter season in the Bering Sea, and then follow the ice edge as it retreats in spring (MacIntyre and Stafford 2011). Large numbers of bearded seals are unlikely to be present in the project area during the time of planned operations. However, some individuals may be encountered. Spotted seals are found in the Bering Sea in winter and spring where they breed, molt, and pup in large groups (Quakenbush 1988; Rugh et al. 1997). Few spotted seals are expected to be encountered in the Chukchi and Beaufort seas until July. Even then, they are rarely seen on pack ice but are commonly observed hauled out on land or swimming in open water (Lowry et al. 1998). The ice overflights are designed to maximize flying over ice, avoiding coastal and terrestrial areas. Haul outs for spotted seals are generally known, and Shell will avoid these areas during the break up surveys.

Based on extensive analysis of digital imagery taken during aerial surveys in support of Shell's 2012 operations in the Chukchi and Beaufort Seas, ice seals are very infrequently observed hauled out on the ice in groups of greater than one individual (LGL unpublished data). Tens of thousands of images from 17 flights that took place from July through October were reviewed in detail. Of 107 total observations of spotted or ringed seals on ice, only three of those sightings were of a group of two individuals (LGL unpublished data). Since seals typically are found as individuals or in very small groups when they are in the project area, the chance of a stampede event is very unlikely. Finally, ice seals are well adapted to move between ice and water without injury, including "escape reactions" to avoid predators.

Ringed and bearded seals sometimes, but not always, dive when approached by low-flying aircraft (Burns and Frost 1979; Burns et al. 1982). Ringed and bearded seals may be more sensitive to helicopter sounds than to fixed-wing aircraft (Burns and Frost 1979). In 2000, a study was conducted to measure the impacts of pipe-driving sounds on pinnipeds at Northstar in the Beaufort Sea (Blackwell et al. 2004). Only some of the ringed seals present exhibited a reaction to an approaching helicopter; of 23 individuals, only 11 reacted; of those 11, 10 increased alertness and only 1 moved into the water (when the helicopter was 100 m away; Blackwell et al. 2004). Reactions of ringed seals while they are in subnivean lairs vary with the characteristics of the flyover, including lateral distance and altitude of aircraft (Kelly et al. 1986).

The sound of aircraft is also reduced by the snow of the lair (Cummings and Holliday 1983). Spotted seals are sensitive to aircraft, reacting erratically at considerable distances which may result in mother-pup separation or injury to pups (Frost et al 1993, Rugh et al. 1993). However, as previously noted, few spotted seals are expected to be present in the project area during the time of planned ice overflights, and overflights will focus on offshore areas as opposed to terrestrial habitat with potential spotted seal haulouts.

Mitigation measures described in the monitoring and mitigation plan (Attachment A) are designed to minimize the potential for behavioral disturbance, injury or mortality. The aircraft will maintain a 1 mi (1.6 km) radius and increase altitude when flying over areas where seals appear to be concentrated in groups of greater than five individuals. Additionally, the aircraft will not land on ice within 0.5 mi (0.8 km) of any hauled out pinnipeds, which is consistent with previous mitigation required by NMFS for aviation activities where ice seals may be present. See e.g., 76 Fed. Reg. at 13132.

As stated in Section 6 of this application, a "take" is defined as a seal exhibiting an escape response, or moving from the ice into the water (from Born et al. 1999). Less dramatic behavioral reactions such as "looking" at the aircraft are not considered to rise to the level of "take by harassment," which is, consistent with NMFS' previous statements, including the following excerpts released by NMFS in association with the 2011 MMPA IHA issued to the USFWS for its polar bear capture/recapture program and the 2012 IHA issued to Shell for the Beaufort Sea drilling program.

"Based on the available data and studies described here, any ringed or bearded seals found in the vicinity of the proposed project are only anticipated to have short-term behavioral reactions to the helicopter flying overhead. Those animals that do dive into a breathing hole or crack in the ice are anticipated to return to the ice shortly after the helicopter leaves the area, as the aircraft generally stays within the same area less than seconds. Hearing impairment (i.e., TTS or PTS) of pinnipeds hauled out on the ice is not anticipated as a result of the USFWS' proposed activity because pinnipeds will likely either dive into breathing holes or the water through cracks in the ice before the helicopter would be close enough to cause such an effect." 76 FR 330.

"Although it is possible that marine mammals could react to any sound levels detectable above the ambient noise level within the animals' respective frequency response range, this does not mean that such a reaction would be considered a take. According to experts on marine mammal behavior, whether a particular stressor could potentially disrupt the migration, breathing, nursing, breeding, feeding, or sheltering, etc., of a marine mammal, i.e., whether it would result in a take, is complex and context specific, and it depends on several variables in addition to the received level of the sound by the animals." 77 FR 27290.

6. TAKE ESTIMATES FOR MARINE MAMMALS

Shell seeks authorization for potential exposure of small numbers of cetaceans and seals under the jurisdiction of the NMFS in the planned region of activity. Species most likely to be encountered include ringed, spotted, and bearded seals. Exposure estimates and requests for potential takes of cetacean species and ribbon seals are also included; however, the estimates of exposure are minimal because these species are relatively uncommon in the Chukchi and Beaufort Seas during the winter and spring when ice overflights will take place. In addition, ice overflights are designed to minimize the amount of time spent flying over open water and adjacent ice edges to reduce the possibility of cetacean encounters. Discussions of estimated exposures are presented below.

The ice overflights planned by Shell are not expected to "take" more than small numbers of marine mammals, or have more than a negligible effect on their populations. It is reasonable to assume all representative sex and age classes of each marine mammal species could be present and exposed during Shell's proposed ice overflight surveys, particularly during spring as several species migrate northward into the Chukchi and Beaufort Seas. Additionally, ringed seals give birth and nurse pups for five to nine weeks in subnivean lairs (e.g., snow caves) connected to their breathing holes during late winter and spring (Smith and Stirling 1975), however, ice overflight surveys are not expected to have additional effects on females or pups other than potential disturbance. Any potential takes would be limited to localized and short-term changes in behavior as the result of survey aircraft overhead. Few, if any, cetaceans are expected to be encountered during ice overflights during winter and also during spring when flight paths will be focused over ice as opposed to open water and ice margins. Only a proportion of the seals hauled out on ice encountered by the overflights are expected to react to the aircraft (Born et al. 1999). The mitigation measures to be applied will minimize exposure of marine mammals to aircraft sounds. In the sections below, we describe methods to estimate exposures and present estimates of the numbers of seals that might be affected during the ice overflights in the Chukchi and Beaufort Seas. The estimates are based on data obtained during marine mammal surveys in and near the planned ice overflight tracklines. Adjustments to reported population or density estimates were made to account for seasonal distributions and population increases or declines insofar as possible.

The main sources of distributional and numerical data used in deriving the estimates are described in the next subsection. There is some uncertainty about the representativeness of those data and the assumptions used below to estimate the potential exposures. However, the approach used here is the best available at this time.

Basis for Estimating "Take by Harassment"

Exposures were calculated in the following sections for cetaceans and seals. The methods used to estimate exposure for each species group was fundamentally the same with minor differences as described below. Exposure estimates for cetaceans were calculated by multiplying the anticipated area to be flown over open water each season (winter and spring) by the expected densities of cetaceans that may occur in the survey area.

Exposures of seals were calculated by multiplying the anticipated area to be flown over open water and ice in each season (winter and spring) by the expected densities of seals that may occur in the survey area by the proportion of seals on ice that may actually show a disturbance reaction to each type of aircraft (Born et al. 1999).

Marine Mammal Density Estimates

Marine mammal density estimates in the Chukchi and Beaufort Seas have been derived for two time periods: the winter period covering November through April, and the spring period including May through early July.

There is some uncertainty about the representativeness of the data and assumptions used in the calculations. To provide some allowance for uncertainties, "average" as well as "maximum" estimates of the numbers of marine mammals potentially affected have been derived. For a few species, several density estimates were available. In those cases, the mean and maximum estimates were determined from the reported densities or survey data. In other cases only one or no applicable estimate was available, so correction factors were used to arrive at "average" and "maximum" estimates. These are described in detail in the following sections.

In Polar Regions, most pinnipeds are associated with sea ice and typical census methods involve counting pinnipeds when they are hauled out on ice. In the Beaufort Sea, abundance surveys typically occur in spring when ringed seals emerge from their lairs (Frost et al. 2004). Depending on the species and study, a correction factor for the proportion of animals hauled out at any one time may or may not have been applied (depending on whether an appropriate correction factor was available for the particular species, area, and time period). By applying a correction factor, the density of the pinniped species in an area can be estimated.

Detectability bias, quantified in part by $f(0)$, is associated with diminishing sightability with increasing lateral distance from the survey trackline. Availability bias, $g(0)$, refers to the fact that there is <100 percent probability of sighting an animal that is present along the survey trackline. Some sources below included these correction factors in the reported densities (e.g. ringed seals in Bengtson et al. 2005) and the best available correction factors were applied to reported results when they had not already been included (e.g. bearded seals in Bengtson et al. 2005).

Cetaceans: Winter

(a) Beluga Whales

Beluga whale density estimates were calculated based on aerial survey data collected in October in the eastern Alaskan Beaufort Sea by the NMML (as part of the BWASP program funded by BOEMRE) in 2007–2010. They reported 31 sightings of 66 individual whales during 1597 km of on-transect effort over waters 200–2000 m deep (Ferguson, M. pers comm.). An f(0) value of 2.326 was applied and it was calculated using beluga whale sightings data collected in the Canadian Beaufort Sea (Innes et al. 2002). A g(0) value of 0.419 was used that represents a combination of ga(0) = 0.55 (Innes et al. 2002) and gd(0) = 0.762 (Harwood et al. 1996). The resulting densities were then multiplied by 0.10 because the Beaufort Sea and north-eastern Chukchi Sea is believed to be at the edge of the species' range in by November. Belugas typically migrate into the Bering Sea for the winter (Allen and Angliss 2014) and are not expected to be present in the study area in the winter. Satellite tagging data support this and indicate belugas migrate out of the Beaufort Sea in the October–November period (Suydam et al. 2005).

(b) Bowhead Whales

Bowhead whale density estimates in the winter in the planned ice overflight area are expected to be quite low. Miller et al. (2002) presented a 10-day moving average of bowhead whale abundance in the eastern Beaufort Sea using data from 1979–2000 that showed a decrease of ~90% from early to late October. Based on these data, it is expected that almost all whales that had been in the Chukchi Sea during early October would likely have migrated beyond the survey areas by November–December. In addition, kernel density estimates and animal tracklines generated from satellite-tagged bowhead whales, along with

acoustic monitoring data, suggest that few bowhead whales are present in the proposed survey area in November (near Point Barrow), and no whales were present in December (ADFG 2010; Moore et al. 2010). Therefore, minimal density estimates (0.0001whales/km^2) were used.

(c) Other Cetacean Species

Other cetacean species are not expected to be present in the area at the time of the planned ice overflight surveys during winter. These species, including humpback whale, fin whale, minke whale, and harbor porpoise, typically migrate during autumn and are expected to be south of the proposed survey area. Gray whales may be encountered as they have been detected near Pt. Barrow throughout the winter (Moore et al. 2006, Stafford et al. 2007). Authorization for minimal takes of other cetacean species that are known to occur in the proposed project area during the summer have been requested in case of a chance encounter with a few individuals as they migrate back into the project area in the late spring.

Table 6-1 Expected Densities of Cetaceans in the Chukchi and Beaufort Seas, Alaska for Planned Winter and Spring Periods.

	Winter		Spring	
Species	Average Density (# / km^2)	Maximum Density (# / km^2)	Average Density (# / km^2)	Maximum Density (# / km^2)
Odontocetes				
Beluga whale	0.0002	0.0006	0.0096	0.0196
Narwhal	0.0000	0.0000	0.0000	0.0001
Killer whale	0.0001	0.0004	0.0001	0.0004
Harbor porpoise	0.0001	0.0004	0.0022	0.0029
Mysticetes				
Bowhead whale	0.0001	0.0004	0.0186	0.0717
Fin whale	0.0001	0.0004	0.0001	0.0004
Gray whale	0.0001	0.0004	0.0253	0.0268
Humpback whale	0.0001	0.0004	0.0001	0.0004
Minke whale	0.0001	0.0004	0.0002	0.0006

*Species listed under the U.S. Endangered Species Act as Threatened are italicized

Cetaceans: Spring

(a) Beluga Whales

Spring densities of beluga whales in offshore waters are expected to be low, with somewhat higher densities in ice-margin and nearshore areas. Past aerial surveys have recorded few belugas in the offshore Chukchi Sea during the summer months and belugas are most likely encountered in offshore waters of the eastern Alaskan Beaufort Sea (Moore et al. 2000). More recent aerial surveys from 2008-2012 flown by the NMML as part of the Chukchi Offshore Monitoring in Drilling Area (COMIDA) project, now part of the Aerial Surveys of Arctic Marine Mammals (ASAMM) project, reported 10 beluga sightings (22 individuals) in offshore waters during 22,154 km of on-transect effort. Larger groups of beluga whales were recorded in nearshore areas, especially in June and July during the spring migration (Clarke and Ferguson *in prep*; Clarke et al. 2012, 2013). Effort and sightings reported by Clarke and Ferguson (*in prep.*) and Clarke et al. (2012, 2013) were used to calculate the average open-water density estimate. Those aerial surveys recorded 10 on-transect beluga sightings (22 individuals) during 22,154 km of on-

transect effort in waters 36-50 m deep in the Chukchi Sea during July and August. The mean group size of the sightings was 2.2. An *f(0)* value of 2.841 and *g(0)* value of 0.58 from Harwood et al. (1996) were also used in the density calculation resulting in an average open-water density of 0.0024 belugas/km^2 (Table 6-1). Specific data on the relative abundance of beluga whales in open-water versus ice-margin habitat during the summer in the Chukchi Sea is not available. However, belugas are commonly associated with ice, particularly ice edges and adjacent polynyas, so an inflation factor of 4 was used to estimate the ice-margin densities from the open-water densities.

(b) Bowhead Whales

Eastward migrating bowhead whales were recorded during industry aerial surveys of the continental shelf near Camden Bay in 2008 until 12 July (Christie et al. 2010). No bowhead sightings were recorded again, despite continued flights, until 19 August. Aerial surveys by industry operators did not begin until late August of 2006 and 2007, but in both years bowheads were also recorded in the region before the end of August (Lyons et al. 2009). The late August sightings were likely of bowheads beginning their fall migration so the densities calculated from those surveys were not used to estimate summer densities in this region. The three surveys in July of 2008 resulted in density estimates of 0.0099, 0.0717, and 0.0186 bowhead whales/km^2, respectively (Christie et al. 2010). The estimate of 0.0186 whales/km^2 was used as the average nearshore density and the estimate of 0 0.0717 whales/km^2 was used as the maximum (Table 6-1). Sea ice was not present during these surveys. Moore et al. (2000) reported that bowhead whales in the Alaskan Beaufort Sea were distributed uniformly relative to sea ice.

(c) Gray Whales

Gray whales are expected to be present in the Chukchi Sea but are unlikely in the Beaufort Sea. Moore et al. (2000) found the distribution of gray whales in Chukchi Sea was scattered and limited to nearshore areas where most whales were observed in water less than 35m deep. The average open-water summer density (Table 6-1) was calculated from 2008–2012 aerial survey effort and sightings in Clarke and Ferguson (in prep) and Clarke et al. (2012, 2013) for water depths 36-50 m including 98 sightings (137 individuals) during 22,154 km of on-transect effort. The average group size of those sightings was 1.4. Correction factors f(0) = 2.49 (Forney and Barlow 1998) and g(0) = 0.30 (Forney and Barlow 1998, Mallonee 1991) were used to calculate and average open-water density of 0.0253 gray whales/km2 (Table 6-1). The highest density from the survey periods reported in Clarke and Ferguson (in prep) and Clarke et al. (2012, 2013) was 0.0268 gray whales/km2 in 2012 and this was used as the maximum open-water density.

(d) Harbor Porpoises

Harbor Porpoise densities were estimated from industry data collected during 2006-2010 activities in the Chukchi Sea. Observers on industry vessels in 2006–2010, however, recorded sightings throughout the Chukchi Sea during the summer months. Density estimates from 2006-2010 observations during non-seismic periods and locations in July-August ranged from 0.0013/km2 to 0.0029/km2 with a maximum 95 percent CI of 0.0137/km2 (Hartin et al. 2013). The average density from the summer season of those three years (0.0022/km2) was used as the average open-water density estimate while the high value (0.0029/km2) was used as the maximum estimate (Table 6-1).

(e) Other Cetacean Species

The remaining five cetacean species that could be encountered in open water in the Chukchi Sea during planned ice overflights include the humpback whale, killer whale, minke whale, fin whale, and narwhal. It is unlikely that more than a few individuals will be encountered during overflights and therefore minimum densities have been assigned to these species (Tables 6-1). Of these uncommon cetacean species, minke whale has the potential to be the most common based on recent industry surveys. Reider et

al. (2013) reported 13 minke whale sightings in the Chukchi Sea in 2013 during Shell's marine survey program. All but one minke whale sighting in 2013 were observed in nearshore areas despite only minimal monitoring effort in these areas (Reider et al. 2013).Clarke et al. (2011, 2013) and Hartin et al. (2013) reported humpback whale sightings; George and Suydam (1998) reported killer whales; Brueggeman et al. (1990); and Clarke et al. (2011, 2013) and Hartin et al. (2013) reported fin whales in the Chukchi Sea. Narwhal sightings in the Alaskan Arctic have not been reported in recent literature, but subsistence hunters occasionally report observations near Barrow, and Reeves et al. (2002) indicated a small number of extralimital sightings.

Pinnipeds: Winter

(a) Ringed Seals

Ringed seal densities were taken from offshore aerial surveys of the pack ice zone conducted in spring 1999 and 2000 (Bengtson et al. 2005). Seal distribution and density in spring, prior to break-up, are thought to reflect distribution patterns established earlier in the year (i.e., during the winter months; Frost et al. 2004). The average density from those two years (weighted by survey effort) was 0.4892 seals/km^2. This value served as the average density while the highest density from the two years (0.8100 seals/km^2 in 1999) was used as the maximum density (Table 6-2).

(b) Other Seal Species

Other seal species are not expected to be present in the ice overflight survey area in large numbers during the winter period of the ice overflights. Bearded, spotted, and ribbon seals would be present in the area in smaller numbers than ringed seals during spring through fall summer, but these less common seal species generally migrate into the southern Chukchi and Bering Seas during fall and remain there through the winter (Allen and Angliss 2014). Few satellite-tagging studies have been conducted on these species in the Beaufort Sea, winter surveys have not been conducted, and a few bearded seals have been reported over the continental shelf in spring prior to general break-up. However, the tracks of three bearded seals tagged in 2009 moved south into the Bering Sea along the continental shelf by November (Cameron and Boveng 2009). These species would be more common in the area during spring through fall, but it is possible that some individuals, bearded seals in particular, may be present in the area surveyed in winter. Ribbon seals are unlikely to be present in the survey area during winter as they also migrate southward from the northeastern Chukchi Sea during this period. In the absence of better information from the published literature or other sources that would indicate that significant numbers of any of these species might be present during winter, minimal density estimates were used for these species. Estimates for bearded seals were assumed to be slightly higher than those for spotted and ribbon seals (Table 6-2).

Pinnipeds: Spring

Three species of pinnipeds under NMFS jurisdiction are likely to be encountered in the Chukchi and Beaufort Seas during planned ice overflights in spring of 2015: ringed, bearded, and spotted seals. Ringed and bearded seals are associated with both the ice margin and the nearshore open water area during spring. Spotted seals are often considered to be predominantly a coastal species except in the spring when they may be found in the southern margin of the retreating sea ice. However, satellite tagging has shown that some individuals undertake long excursions into offshore waters during summer (Lowry et al. 1994, 1998). Ribbon seals have been reported in very small numbers within the Chukchi Sea by observers on industry vessels (Patterson et al. 2007, Hartin et al. 2013).

(a) Ringed Seal and Bearded Seal

Ringed seal and bearded seal "average" and "maximum" spring densities (Table 6-2) were available in Bengtson et al. (2005) from spring surveys in the offshore pack ice zone (zone 12P) of the northern Chukchi Sea. However, corrections for bearded seal availability, g(0), based on haulout and diving patterns were not available.

(b) Spotted Seal

Little information on spotted seal densities in offshore areas of the Alaskan Arctic is available. Spotted seal densities in the spring were estimated by multiplying the ringed seal densities by 0.02. This was based on the ratio of the estimated occurrence of the two species during ice overflight surveys and the assumption that the vast majority of seals present in areas of pack ice would be ringed seals.

(c) Ribbon Seal

Four ribbon seal sightings were reported during industry vessel operations in the Chukchi Sea in 2006-2010 (Hartin et al. 2013). The resulting density estimate of 0.0007/km2 was used as the average density and 4 times that was used as the maximum for the spring season.

Table 6-2 Expected Densities of Seals in the Chukchi and Beaufort Seas, Alaska for Planned Winter and Spring Periods.

	Winter		Spring	
Species	Average Density (# / km^2)	Maximum Density (# / km^2)	Average Density (# / km^2)	Maximum Density (# / km^2)
Pinnipeds				
Bearded Seal	0.0004	0.0016	0.0142	0.0270
Ribbon seal	0.0001	0.0004	0.0007	0.0028
Ringed seal	0.4892	0.8100	0.4892	0.8100
Spotted seal	0.0001	0.0004	0.0098	0.0162

*Species listed under the U.S. Endangered Species Act as Threatened are italicized

Ice Overflight Survey Summary

The proposed ice overflight program will be operated in several intermittent stages beginning in May of 2015 and concluding in May of 2016. Approximately 14 surveys will be flown in total during this period using a combination of fixed-wing aircraft and helicopters. Total estimated flight distances for each type of aircraft and season are shown in Table 6-3. Flight altitudes for fixed wing surveys will mostly be at or above 152 m and range from 30 to 610 m. For helicopter flights, the altitude will mostly be at or above 61 m (200 ft.) with a range of 15 to 152 m. The helicopter will also land on ice during midwinter surveys if it is safe to do so and no seals are present within an 805 m radius of the landing location. Identification and assessment of ice features are key objectives of the surveys, and as a result flight paths will avoid areas of open water and adjacent ice edges.

Table 6-3 Maximum Proposed Flight Distances (km) by Season for Fixed Wing Aircraft and Helicopters in the Chukchi and Beaufort Seas, Alaska, During the Planned 2015-2016 Ice Overflight Survey Program.

	Maximum Proposed Flight Distance	
Aircraft	**Winter**	**Spring**
Fixed Wing	4,630	2,778
Helicopter	370	370
Grand Totals	***5,000***	***3,148***

Estimated Areas Where Cetaceans May be Encountered by Aircraft

Encounters that may result in potential disturbance of cetaceans will likely occur only in open water. Flight paths over open water and adjacent ice edges will be minimized by the objectives of the program as an effort to reduce encounters with cetaceans. It is estimated that five to ten percent of distance flown in winter will be over open water, and ten to twenty percent of distance flown in spring will be over open water. We applied the most conservative of these percentages to the proposed tracklines in winter and spring to estimate the area of open water exposed by planned ice overflights.

The potential disturbance area for each season was based on flight altitude and lateral distance of cetaceans from the center trackline. Based on known air-to-water propagation paths, cetaceans may be exposed to sounds produced by the aircraft when individuals are up to 13 degrees from the aircraft's center (Snell's law; Urick 1972 *in* Richardson et al. 1995). It was assumed that cetaceans in open water could be disturbed within 13 degrees of vertical (i.e., a 26-degree cone) from the location of an aircraft when aircraft are 305 m or lower. We assumed aircraft above this altitude would not appreciably disturb cetaceans in open water below. This 305-m maximum disturbance altitude and Snell's law results in a maximum potential disturbance radius of approximately 70 m. Based on Snell's law (Urick 1972 *in* Richardson et al. 1995) and a 305 m flight altitude, we used a conservative radius of 75 m to calculate the potential disturbance area beneath an aircraft for cetaceans in open-water conditions.

Table 6-4 summarizes potential disturbance radii, maximum flight distances over open water, and potential disturbance areas for cetaceans from fixed wing aircraft and helicopters during Shell's proposed ice overflights program in winter (November through April) and spring (May through early July). Maximum percentage of total trackline over open water, as based on previous surveys, is 10% and 20% of the total trackline for winter and spring, respectively. Based on maximum flight distances, percent open water, and a potential disturbance radius of 75 m for fixed wing aircraft and helicopters, a total of 169 km^2 of open-water could be disturbed. Approximately 45% of this total estimated open-water area would be surveyed in winter and the remaining 55% would be surveyed during spring.

Table 6-4 Potential Disturbance Radii, Maximum Flight Distances over Open Water, and Potential Disturbance Areas for Cetaceans in Open Water from Fixed Wing Aircraft and Helicopters in the Chukchi and Beaufort Seas, Alaska, During the Planned 2015-2016 Ice Overflight Survey Program.

Aircraft	Potential Disturbance Radius (km)	Maximum Open Water Flight Distance (km)		Potential Disturbance Area (km^2)	
		Winter	Spring	Winter	Spring
Fixed Wing	0.075	463	556	69	83
Helicopter	0.075	37	74	6	11
Grand Totals		***500***	***630***	***75***	***94***

Estimated Areas Where Seals May be Encountered by Aircraft

Fixed wing and helicopter flights over ice at ice overflight survey altitudes have the potential to disturb seals hauled out on ice, although the flight altitude and lateral distances at which seals may react to aircraft are highly variable (Born et al. 1999; Burns et al. 1982; Burns and Frost 1979). The probability of a seal hauled out on ice reacting to a fixed wing aircraft or helicopter is influenced by a combination of variables such as flight altitude, lateral distance from the aircraft, ambient conditions (e.g., wind chill), activity, and time of day (Born et al. 1999). Evidence from flyover studies of ringed and bearded seals suggests that a reaction to helicopters is more common than to fixed wing aircraft, all else being equal (Born et al. 1999; Burns and Frost 1979).

Born et al. (1999) investigated the reactions of ringed seals hauled out on ice to aircraft. The threshold lateral distances from the aircraft trackline out to which the vast majority of reactions were observed were 600 and 1500 m for fixed wing aircraft and helicopters, respectively. Many individual ringed seals within these distances; however, did not react. (Born et al. 1999). Results indicated ~6% and ~49% of total seals observed reacted to fixed wing aircraft and helicopters, respectively, by entering the water when aircraft were flown over ice at altitudes similar to those proposed for Shell's ice overflight surveys. These lateral distances and reaction probabilities were used as guidelines for estimating the area of sea ice habitat within which hauled out seals may be disturbed by aircraft and the number of seals that might react. Born et al. 1999, also was used as a guideline in a similar fashion for estimating the numbers of seals that would react to helicopters during US Fish and Wildlife Service polar bear tagging in 2011 and 2012, in which an IHA was issued by NMFS (NMFS 2011).

Table 6-5 summarizes potential disturbance radii, maximum flight distances, and potential disturbance areas for seals from fixed wing aircraft and helicopters during Shell's proposed ice overflights program in winter (November through April) and spring (May through early July). Based on maximum flight distances and potential disturbance radii of 600 and 1500 m for fixed wing aircraft and helicopters, respectively, a total of 11,112 km^2 (of sea ice could be disturbed. Based on Born et al.'s (1999) observations, however, it is estimated that only ~6 and ~49% of seals in these areas will exhibit a notable reaction to fixed wing aircraft and helicopters, respectively, by entering the water. Approximately 60% of this total area would be surveyed in winter and the remaining 40% would be surveyed during spring.

Table 6-5 Potential Disturbance Radii, Maximum Flight Distances, and Potential Disturbance Areas for Seals from Fixed Wing Aircraft and Helicopters in the Chukchi and Beaufort Seas, Alaska, During the Planned 2015-2016 Ice Overflight Survey Program.

Aircraft	Potential Disturbance Radius (km)	Maximum Flight Distance (km)		Potential Disturbance Area (km^2)	
		Winter	Spring	Winter	Spring
Fixed Wing	0.6	4,630	2,778	5,557	3,335
Helicopter	1.5	370	370	1,110	1,110
Grand Totals		***5,000***	***3,148***	***6,667***	***4,445***

Potential Numbers of Exposures

Cetaceans

This subsection provides estimates of the number of individual cetaceans that could potentially be disturbed by aircraft during Shell's proposed ice overflights. The estimates are based on an estimate of the anticipated open-water area that could be subjected to disturbance from overflights, proximity of cetaceans in open water to the aircraft, and expected cetacean densities in those areas during each season.

The number of individuals of each cetacean species potentially disturbed by fixed wing aircraft or helicopters was estimated by multiplying

- the potential disturbance area from each aircraft (fixed wing and helicopter) for each season (winter and spring), by
- the percentage of survey area expected to be over open water as opposed to ice in each season, by
- the expected cetacean density for each season.

The numbers of individual cetaceans potentially disturbed were then summed for each species across the two seasons.

Estimates of the average and maximum number of individual cetaceans that may be disturbed are shown by season in Table 6-6. Less than one individual of each cetacean species was estimated to be disturbed in winter. This was due to the low density of cetaceans in the survey area in winter and extensive ice cover during this period. In spring, a few beluga whales, bowhead whales, and gray whales are estimated to potentially be disturbed during ice overflights when aircraft transit over open water for short periods. The numbers of individuals exposed represent very small proportions of their populations.

Pinnipeds

This subsection provides estimates of the number of individual ice seals that could potentially be disturbed by aircraft during Shell's proposed ice overflights. The estimates are based on a consideration of the proposed flight distances, proximity of seals to the aircraft trackline, and the proportion of ice seals present that might actually be disturbed appreciably (i.e. moving from the ice into the water) by flight operations in the Chukchi and Beaufort Seas and the anticipated area that could be subjected to disturbance from overflights.

The number of individuals of each ice seal species potentially disturbed by fixed wing aircraft or helicopters was estimated by multiplying

- the potential disturbance area from each aircraft (fixed wing and helicopter) for each season (winter and spring), by
- the expected seal density in each season, and by
- the expected proportion of seals expected to react to each type of aircraft in a way that could be interpreted as disturbance.

The numbers of individuals potentially disturbed were then summed for each species across the two seasons.

Estimates of the average and maximum number of individual seals that may be disturbed are shown by season in Table 6-7. The estimates shown represent proportions of the total number of seals encountered that may actually demonstrate a disturbance reaction to each type of aircraft. Estimates shown in Table 6-7 were based on Born et al. 1999, which assumed that ~6 and ~49% of seals would react within lateral distances of 600 and 1,500 m of fixed wing aircraft and helicopters, respectively.

Ringed seal is by far the most abundant species expected to be encountered during the planned ice overflights. The best (average) estimate of the numbers of ringed seals potentially disturbed during ice overflights is 793 individuals, which represents only a small proportion of the estimated population of ringed seals in the Chukchi and Beaufort Seas. Fewer individuals of other pinniped species are estimated to be encountered during ice overflights, also representing very small proportions of their populations.

Table 6-6 Potential Number of Cetaceans Disturbed by Fixed Wing Aircraft and Helicopters in the Chukchi and Beaufort Seas, Alaska During the Planned 2015-2016 Ice Overflight Program.

	Fixed Wing						Helicopter							
	Winter		Spring		Total		Winter		Spring		Total		Grand Total	
	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
Odontocetes														
Beluga whale	0	0	1	2	1	2	0	0	0	0	0	0	1	2
Narwhal	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Killer whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harbor porpoise	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mysticetes														
Bowhead whale	0	0	2	6	2	6	0	0	0	1	0	1	2	7
Fin whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gray whale	0	0	2	2	2	2	0	0	0	0	0	0	2	3
Humpback whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minke whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6-7 Potential Number of Seals Disturbed by Fixed Wing Aircraft and Helicopters in the Chukchi and Beaufort Seas, Alaska, During the Planned 2015-2016 Ice Overflight Program. Estimates Shown Represent Proportions of the Total Number of Seals Encountered that may Demonstrate a Disturbance Reaction to Each Type of Aircraft Based on Born et al. 1999.

	Fixed Wing						Helicopter							
	Winter		Spring		Total		Winter		Spring		Total		Grand Total	
	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
Pinnipeds														
Bearded seal	0	1	3	5	3	6	0	1	8	15	8	16	11	21
Ribbon seal	0	0	0	1	0	1	0	0	0	2	0	2	1	2
Ringed seal	163	270	98	162	261	432	266	441	266	441	532	881	793	1313
Spotted seal	0	0	2	3	2	3	0	0	5	9	5	9	7	12

7. ANTICIPATED IMPACT OF THE ACTIVITY

The reasonably expected or reasonably likely impacts of the specified activities on marine mammals will be related primarily to localized, short-term acoustic disturbance from aircraft flying primarily over areas covered by sea ice with limited flight activity over open water and adjacent ice edges. The acoustic sense of marine mammals probably constitutes their most important distance receptor system. Potential acoustic effects relate to sound produced by helicopters and fixed-wing aircraft.

Evidence from flyover studies of ringed and bearded seals suggests that a reaction to helicopters is more common than to fixed wing aircraft, all else being equal (Born et al. 1999; Burns and Frost 1979). Under calm conditions, rotor and engine sounds are coupled into the water through ice within a 26° (degree) cone beneath the aircraft (Snell's law; Urick 1972 in Richardson et al. 1995). Scattering and absorption, however, will limit lateral propagation in the shallow water (Greene and Moore 1995).

Dominant tones in noise spectra from helicopters are generally below 500 Hz (Greene and Moore 1995). Harmonics of the main rotor and tail rotor usually dominate the sound from helicopters; however, many additional tones associated with the engines and other rotating parts are sometimes present. Because of Doppler shift effects, the frequencies of tones received at a stationary site diminish when an aircraft passes overhead. The apparent frequency is increased while the aircraft approaches and is reduced while it moves away.

Aircraft flyovers are not heard underwater for very long, especially when compared to how long they are heard in air as the aircraft approaches an observer. Very few cetaceans are expected to be encountered during ice overflights due to the low density of cetacean species in the winter survey area and small area to be flown over open water during spring. Long-term or population level effects are not expected. The majority of seals encountered by fixed wing aircraft will unlikely show a notable disturbance reaction, and approximately half of the seals encountered by helicopters may react by moving from ice into the water (Born et al. 1999). Any potential disturbance from aircraft to seals in the area of ice overflights will be localized and short-term in duration with no population level effects.

Historically, there have been far greater levels of aviation activity in the offshore Chukchi and Beaufort Seas compared with that of the proposed ice overflights. None of this previous offshore aviation activity is believed to have resulted in long-term impacts to marine mammals, as demonstrated by results from a wide range of monitoring programs and scientific studies. Impacts to marine mammals from aviation activities in Arctic offshore habitats have been shown to be, at most, short-term and highly-localized in nature (e.g., Funk et al. 2013; Richardson et al. 1985a,b; Patenaude et al. 2002; Born et al. 1999).

An onboard PSO will document all marine mammal sightings during ice overflights and collect data related to the behavior and potential reaction of each individual. These data will be analyzed following ice overflights to assess the observed level of behavioral disturbance resulting from the proposed activity. The potential impact, consistent with previous findings, is predicted to be short-term, highly-localized, and involve only small numbers of individual marine mammals. These impacts are consistent with the findings by NMFS detailed in the Notice of Issuance for the 2011 IHA issued to the USFWS for Polar Bear Capture survey activities (76 FR 13130).

8. ANTICIPATED IMPACTS ON SUBSISTENCE USERS

Subsistence hunting continues to be an essential aspect of Inupiat Native life, especially in rural coastal villages. The Inupiat participate in subsistence hunting activities in and around the Beaufort and Chukchi Seas. The animals taken for subsistence provide a significant portion of the food that will last the community through the year. Marine mammals represent on the order of 60-80% of the total subsistence harvest. Along with the nourishment necessary for survival, the subsistence activities strengthen bonds within the culture, provide a means for educating the younger generation, provide supplies for artistic expression, and allow for important celebratory events. In this IHAA Shell specifically discusses the potential impact of the planned ice overflight surveys on subsistence uses of bowheads, belugas, and ice seals, which are the primary marine mammals harvested for subsistence.

Bowhead Whale

Activities associated with Shell's planned ice overflight survey program will not have an un-mitigable adverse impact on the availability of bowhead whales for taking for subsistence uses. Ice overflight surveys that may occur near Point Lay, Wainwright, Barrow, Nuiqsut, and Kaktovik would traverse bowhead subsistence areas. Most flights would take place after the date of fall and prior to spring bowhead whale hunting from the villages. The most commonly observed reactions of bowheads to aircraft traffic are hasty dives, but changes in orientation, dispersal, and changes in activity are sometimes noted. Such reactions could potentially affect subsistence hunts if the flights occurred near and at the same time as the hunt. Shell has developed and proposes to implement a number of mitigation measures to avoid such impacts. These mitigation measures include minimum flight altitudes, use of Village Community Liaison Officers (CLOs), Subsistence Advisors (SAs), and Communication Centers as described below in Section 12 in order to avoid conflicts with subsistence activities. SA calls will be held while subsistence activities are underway during the ice overflight survey program and are attended by operations staff, logistics staff, and CLOs. Aircraft flights are adjusted as needed and planned in a manner that avoids potential impacts to bowhead whale hunts and other subsistence activities. With these mitigation measures any effects on the bowhead whale as a subsistence resource, or effects on bowhead subsistence hunts would be minimal.

Beluga Whale

Activities associated with Shell's planned ice overflight survey program will not have an un-mitigable adverse impact on the availability of beluga whales for taking for subsistence uses.

Ice overflight surveys may occur near Point Lay, Wainwright, Barrow, Nuiqsut, and Kaktovik would and traverse beluga whale hunt subsistence areas. Most flights would take place when belugas are not typically harvested. Survey activities could potentially affect subsistence hunts if the flights occurred near and at the same time as the hunt. Shell has developed and proposes to implement a number of mitigation measures to avoid such impacts. These mitigation measures include minimum flight altitudes, use of CLOs, SAs, and Communication Centers as described below in Section 12. SA calls will be held while subsistence activities are underway during the ice overflight survey program and are attended by operations staff, logistics staff, and CLOs. Aircraft flights are adjusted as needed and planned in a manner that avoids potential impacts to beluga whale hunts and other subsistence activities. With these mitigation measures any effects on the beluga whale as a subsistence resource, or effects on beluga subsistence hunts would be minimal.

Seals

Seals are an important subsistence resource with ringed and bearded seals making up the bulk of the seal harvest. The survey areas are far outside of areas reportedly utilized for the harvest of seals by the villages of Point Hope, thus the ice overflight surveys will not have an un-mitigable adverse impact on the availability of ice seals for taking for subsistence uses. The survey areas encompass some areas utilized by residents of Point Lay, Wainwright, Barrow, Nuiqsut and Kaktovik for the harvest of seals. Most ringed and bearded seals are harvested in the winter and a harvest of seals could possibly be affected by Shell's planned activities. Spotted seals are harvested during the summer and may overlap briefly with Shell's planned activities. Most seals are harvested in coastal waters, with available maps of recent and past subsistence use areas indicating that seal harvests have occurred only within 30-40 mi (48-64 km) off the coastline. Some of the planned ice overflight surveys would take place in areas used by the village residents for the harvest of seals. The survey aircraft could potentially travel over areas used by residents for seal hunting and could potentially disturb seals and, therefore, subsistence hunts for seals. Any such effects from the survey activities would be minimal due to the infrequency of the planned surveys. Shell has developed and proposes to implement a number of mitigation measures which include a proposed 4MP (Attachment A), use of CLOs, SAs, operation of Communication Centers, and minimum altitude requirements as described in Section 12. SA calls will be held while subsistence activities are underway during the ice overflight survey program and are attended by operations staff, logistics staff, and CLO's. Aircraft movements and activities are adjusted as needed and planned in a manner that avoids potential impacts to subsistence activities. With these mitigation measures any effects on ringed, bearded, and spotted seals as subsistence resources, or effects on subsistence hunts for seals, would be minimal.

9. ANTICIPATED IMPACTS ON HABITAT

Shell's planned 2015/16 ice overflight surveys will not result in any permanent impact on habitats used by marine mammals, or to their prey sources. The primary potential impacts on marine mammal habitat and prey resources that are reasonably expected or reasonably likely are associated with elevated sound levels from the aircraft passing overhead. Effects on marine mammal habitat from the generation of sound from the planned surveys would be negligible and temporary, lasting only as long as the aircraft is overhead. Water column effects will be localized and ephemeral lasting only the duration of the aircrafts presence. All effects on marine mammal habitat from the planned surveys are expected to be negligible and confined to very small areas within the Chukchi and Beaufort Seas.

Potential Impacts on Habitat from Sound Generation

The primary effect of the sound energy generated by ice overflight survey activities on marine mammal habitat will be the ensonification of the water column and air at the surface. Impacts on marine mammals from ensonification are described above in Section 7. Sound energy can also affect invertebrates and fish that are marine mammal prey, and thereby indirectly impact the marine mammals.

Levels and duration of sounds received by marine mammals underwater from a passing helicopter or fixed-wing aircraft are a function of the type of aircraft, orientation and altitude of the aircraft, depth of the animal, and water depth. Aircraft sounds are detectable underwater at greater distances when the receiver is in shallow rather than deep water. Generally, sound levels received underwater decrease as the altitude of the aircraft increases (Richardson et al. 1995a). The nature of sounds produced by aircraft activities does not pose a direct threat to the underwater marine mammal habitat or prey.

Aircraft sounds are audible for much greater distances in air than in water. Under calm conditions, rotor and engine sounds are coupled into the water within a 26 degree cone beneath the aircraft. Some of the sound will transmit beyond the immediate area, and some sound will enter the water outside the 26 degree area when the sea surface is rough. However, scattering and absorption will limit lateral propagation in shallow water. Dominant tones in noise spectra from helicopters are generally below 500 Hz (Greene and Moore 1995). Because of Doppler shift effects, the frequencies of tones received at a stationary site diminish when an aircraft passes overhead. The apparent frequency is increased while the aircraft approaches and is reduced while it moves away. Sounds generated underwater from aircraft flyovers are of short duration.

Helicopters will generally maintain straight-line routes, thereby limiting the sound levels at and below the surface. Given the timing and location of the proposed ice overflight activities, as well as the mitigation measures that will be implemented as a part of the program, any impacts from aircraft traffic on marine mammal habitat or prey will be localized and temporary with no anticipated population level effects.

10. ANTICIPATED EFFECTS OF HABITAT IMPACTS ON MARINE MAMMALS

The effects of the planned activities on habitat will be negligible, as described in Section 9. It is estimated that only a small portion of the animals utilizing the areas of the proposed activities could be temporarily displaced.

During the period of the ice overflight surveys, most cetaceans would be south of the Chukchi Sea. The northward migration of bowhead whales through the Beaufort and Chukchi Seas typically occurs in April and May, and efforts to reduce potential impacts during this period, such as such as increasing survey altitude over leads and open water will provide effective protection of the bowhead migration and possible subsistence hunts. Small numbers of feeding gray whales may also be present proximal to surveys in the Chukchi Sea in June and July. Small numbers of ice seals may be present proximal to surveys in both seas. The numbers of cetaceans and pinnipeds that might be subject to displacement are small in relation to abundance estimates for the mammals addressed under this IHAA.

Bowheads, gray, or belugas are not predicted to be excluded from any habitat nor are any seals predicted to be excluded from any habitat by the surveys.

The proposed activities are not expected to have any habitat-related effects that would produce long-term affects to marine mammals or their habitat due to the limited extent of the survey areas and timing of the activities.

11. MITIGATION MEASURES

Shell proposes a suite of mitigation measures to minimize any adverse impacts associated with the ice overflight surveys in the Chukchi and Beaufort Sea. These include, among others discussed in the 4MP (See Attachment A), the following: (1) the timing and locations for active survey acquisition work; and (2) increasing altitude or deviating from survey tract when the protected species observers sight visually (from the aircraft) the presence of marine mammals. The mitigation measures are presented in the 4MP. To summarize:

- A PSO will be aboard all flights recording all sightings/observations (e.g. including number of individuals, approximate age (when possible to determine), and any type of potential reaction to the aircraft. Environmental information the observer will record includes weather, air temperature, cloud and ice cover, visibility conditions, and wind speed.
- The aircraft will maintain a 1 mi radius when flying over areas where seals appear to be concentrated in groups of ≥ 5 individuals;
- The aircraft will not land on ice within 0.5 mi of hauled out pinnipeds or polar bears;
- The aircraft will avoid flying over polynyas and along adjacent ice margins as much as possible to minimize potential disturbance to cetaceans; and
- Shell will routinely engage with local communities and subsistence groups to ensure no disturbance of whaling or other subsistence activities.

12. ARCTIC SUBSISTENCE PLAN OF COOPERATION

A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation

Shell is preparing to implement a Plan of Cooperation (POC) in accordance NMFS' regulations. The POC relies upon the Chukchi Sea Communication Plans (Attachment B) to identify the measures that Shell has developed in consultation with North Slope subsistence communities and will implement during its planned 2015/2016 ice overflight surveys to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, the POC will detail Shell's communications and consultations with local subsistence communities concerning its planned 2015/2016 program, potential conflicts with subsistence activities, and means of resolving any such conflicts (50 CFR §216.104(a) (12) (i), (ii), (iv)). Shell continues to document its contacts with the North Slope subsistence communities, as well as the substance of its communications with subsistence stakeholder groups.

The POC will be, and has been in the past, the result of numerous meetings and consultations between Shell, affected subsistence communities and stakeholders, and federal agencies. The POC identifies and documents potential conflicts and associated measures that will be taken to minimize any adverse effects on the availability of marine mammals for subsistence use. Outcomes of POC meetings are typically included in updates attached to the POC as addenda and distributed to federal, state, and local agencies as well as local stakeholder groups that either adjudicate or influence mitigation approaches for Shell's activities.

Shell will engage with the villages potentially impacted by the 2015/2016 ice overflight surveys in the Chukchi and Beaufort Seas in2014 and early 2015. Meetings were held in Barrow and Point Lay in early November and additional engagements are scheduled with other villages in early 2015. Throughout 2015, and 2016 Shell anticipates continued engagement with the marine mammal commissions and committees active in the subsistence harvests and marine mammal research.

Following the 2015/2016 season, Shell intends to have a post-season co-management meeting with the commissioners and committee heads to discuss results of mitigation measures and outcomes of the preceding season. The goal of the post-season meeting is to build upon the knowledge base, discuss successful or unsuccessful outcomes of mitigation measures, and possibly refine plans or mitigation measures if necessary.

A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation

Barrow and Point Lay were consulted in November 2014 and additional effected communities will be consulted in early 2015 regarding Shell's overflight survey activity. Additionally, Shell will meet with the NSB Assembly and the Alaska Eskimo Whaling Commission (AEWC). The dates of these consultations and the presented materials will be included in the POC via addenda once they have occurred.

A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing

The following mitigation measures, plans, and programs are integral to this POC and were developed during previous consultations with potentially affected subsistence groups and communities. These measures, plans, and programs to monitor and mitigate potential impacts to subsistence users and resources will be implemented by Shell during its activities in the Chukchi and Beaufort Seas.

The mitigation measures Shell has adopted and will implement during its ice overflight surveys are listed and discussed below. These mitigation measures reflect Shell's experience conducting exploration activities in the Alaska Arctic OCS since the 1980s and its ongoing efforts to engage with local subsistence communities to better understand their concerns and develop appropriate and effective mitigation measures to address those concerns. This most recent version of Shell's planned mitigation measures was presented to community leaders and subsistence user groups starting in January 2009 and has evolved since in response to information learned during the consultation process.

Subsistence Mitigation Measures

Communications

- Shell has developed a Communication Plan and will implement this plan before initiating ice overflight survey operations to coordinate activities with local subsistence users, as well as Village Whaling Captains' Associations, to minimize the risk of interfering with subsistence hunting activities, and keep current as to the timing and status of the bowhead whale hunt and other subsistence hunts.
- Shell will employ local CLOs and/or SAs from the Chukchi Sea villages that are potentially impacted by Shell's ice overflight surveys. The CLOs and SAs will provide consultation and guidance regarding the whale migration and subsistence activities. There will be one per village. The CLO and/or SA will use local knowledge (Traditional Knowledge) to gather data on the subsistence lifestyle within the community and provide advice on ways to minimize and mitigate potential negative impacts to subsistence resources during the survey season. Responsibilities include reporting any subsistence concerns or conflicts; coordinating with subsistence users; reporting subsistence-related comments, concerns, and information; and advising how to avoid subsistence conflicts.

Aircraft Travel

- The aircraft will maintain a 1 mi (1.6 km) radius when flying over areas where seals appear to be concentrated in groups of $\geq$ 5 individuals.
- The aircraft will not land on ice within 0.5 mi (805 m) of hauled out pinnipeds.
    - The aircraft will avoid flying over polynyas and along adjacent ice margins as much as possible to minimize potential disturbance to cetaceans.
    - Aircraft shall not operate below 1,500 ft. (457 m) in areas of active whale hunting; such areas to be identified through communications with the Com Centers and SAs.
- Shell will routinely engage with local communities and subsistence groups to ensure no disturbance of whaling or other subsistence activities.

What plans does the applicant have to continue to meet with the affected communities prior to and while conducting the activity, to resolve conflicts and notify the communities of any changes in the operation.

Shell will meet with the potentially affected communities of the Chukchi and Beaufort Seas to introduce the 2015/16 ice overflight survey program. These meetings will serve to facilitate early identification of key issues and permitting requirements.

Through the CLO, SA, and Communications and Call Center program for 2015 and 2016, Shell will continue to stay in contact with the potentially affected communities. The CLO and/or SA provide the residents of the communities a way to communicate where and when subsistence activities will occur so that industry may avoid conflicts with planned subsistence activities. The Com and Call Center protocols enable industry to inform residents daily of industry activities and planned movements. These programs provide for two-way communication and foster opportunities for mitigation of industry activities that may in some way potentially conflict with planned subsistence activities.

13. MONITORING AND REPORTING

Shell's application includes a detailed description of the monitoring program that will be implemented in conjunction with the ice overflight survey (Attachment A; 4MP). With respect to monitoring, NMFS' regulations state that an applicant must describe "the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding." 50 C.F.R. 216.104(a)(13). In addition, for activities that occur in Arctic waters, the monitoring program "must, if appropriate, document the effects (including acoustical) on marine mammals and document or estimate the actual level of take. . . . ." See id. at 216.108(c).

Given the area of open water available to survey, and the number of hours of survey time proposed, it would be statistically improbable to be able to detect a potential change to marine mammal populations associated with the ice overflight activities. The total survey area represents a very small fraction of the total habitat in the Chukchi and Beaufort Seas. The amount of pre- and post-overflight survey effort required to detect a change in marine mammal distribution or abundance would entail months (if not more) of systematic surveying before and after the proposed ice overflights. Moreover, such an approach would be particularly unrealistic in this case considering the anticipated ice overflight impact area is at most 1.5 km on either side of a helicopter flight path and even smaller (0.6 km) on either side of a fixed-wing aircraft (based on Born et al. 1999 for pinnipeds on ice and Urick 1972 in Richardson et al. 1995 for cetaceans).

Additionally, marine mammal distributions and environmental conditions before, during, and after ice overflights would differ considerably (summarized in LGL and Industry Contributors 2014), making any comparison of results between those periods tenuous at best. The scales of temporal and spatial variation in offshore Arctic environmental conditions and marine mammal distribution/abundance across the proposed overflight period are far greater than would be any detectable, potential long-term impacts on marine mammals. For example, consider the following scenario: pre-overflight surveys in the Chukchi Sea during spring detected large numbers of bowhead whales, and post-overflight surveys during the summer detected very few bowhead whales. The most plausible interpretation would be that the temporal and spatial nature of the annual bowhead migration, not limited ice overflight activities, were the main factors behind the observed results.

In other words, natural changes in marine mammal distribution/abundance over time and space, in addition to changing environmental conditions that affect marine mammal distribution and abundance (e.g., ice cover), would preclude the ability of pre- and post-overflight surveys to detect a long-term impact to marine mammals stemming from isolated ice overflights within a negligible area of the total habitat in the Chukchi and Beaufort Seas.

From an impact standpoint, an onboard PSO will document all marine mammal sightings during ice overflights and collect data related to the behavior and potential reaction of each individual. These data will be analyzed following ice overflights to assess the observed level of behavioral disturbance resulting from the proposed activity. The potential impact is predicted to be short-term, highly-localized, and involve only small numbers of individual marine mammals.

In conclusion, Shell's proposed monitoring plan is consistent with NMFS' regulations and past monitoring measures required for similar activities. See 76 Fed. Reg. at 13132. The plan includes measures to collect and record data on marine mammals and their associated behavior and will result in increased knowledge of the species and level of taking in the area for the seasonal periods the surveys

occur. The extensive, additional aviation activity recommended by NMFS would not produce meaningful results, at least in the context of this survey. Also, any additional aircraft activity would increase operational costs and result in increased risk to human safety as operators would need to spend more time in their aircraft flying greater distances over the Chukchi Sea. Finally, additional aviation activity could produce unintended consequences such as short-term behavioral disturbance to marine mammals not located within the project area.

14. SUGGESTED MEANS OF COORDINATION

Various agencies and programs currently undertake marine mammal studies in the Chukchi and Beaufort Seas. Shell is prepared to share information obtained during implementation of our 4MP with a variety of groups who may find the data useful in their research. A suggested list of recipients includes: The NSB Department of Wildlife Management (T. Hepa).

- The North Slope Borough Department of Wildlife Management (T. Hepa)
- The USFWS Office of Marine Mammal Management (C. Perham, C. Putnam and J. MacCracken)
- The BOEM Aerial Surveys of Arctic Marine Mammals Program (C. Fairfield)
- National Oceanic and Atmospheric Association, National Marine Mammal Laboratory (R. Angliss)
- Alaska Eskimo Whaling Commission (G. Noongwook - Savoonga)
- Beluga Whale Committee (W. Goodwin - Kotzebue)
- Alaska Ice Seal Commission (J. Goodwin-Kotzebue)
- Inupiat Community of the Arctic Slope (D. Lampe - Barrow)
- Alaska Nanuq Commission (J. Omelak)
- North Slope Science Initiative (J. Payne)
- Alaska Department of Natural Resources (S. Longan)
- Alaska Department of Fish and Game

15. CITED LITERATURE

ADFG (Alaska Department of Fish and Game). 2010. Satellite Tracking of Western Arctic Bowhead Whales. Preliminary reports and summaries available at: http://www.wildlife.alaska.gov/index.cfm?adfg=marinemammals.bowhead

Aerts, L.A.M., W. Hetrick, S. Sitkiewicz, C. Schudel, D. Snyder, and R. Gumtow. 2013. Marine mammal distribution and abundance in the northeastern Chukchi Sea during summer and early fall, 2008-2012. Final Report prepared by LAMA Ecological for ConocoPhillips Company., Shell Exploration and Production Company and Statoil USA E&P, Inc.

Allen, B.M., and R.P. Angliss. 2014. Alaska Marine Mammal Stock Assessments, 2013. U.S. Dep. Commer., NOAA Technical Memorandum NMFS-AFSC-277, 294 p.

Bengtson, J.L., L.M. Hiruki-Raring, M.A. Simpkins, and P.L. Boveng. 2005. Ringed and bearded seal densities in the eastern Chukchi Sea, 1999-2000. Polar Biol. 28:833-845-230.

Blackwell, S.B., J.W. Lawson, and M.T. Williams. 2004. Tolerance by ringed seals (Phoca hispida) to impact pipe-driving and construction sounds at an oil production island. J. Acoust. Soc. Am. 115 (5): 2346-2357.

Bluhm, B.A., K.O. Coyle, B. Konar and R. Highsmith. 2007. High gray whale relative abundances associated with an oceanographic front in the south-central Chukchi Sea. Deep-sea Research II 54:2919-2933.

Bluhm, B.A. and R. Gradinger. 2008. Regional variability in food availability for arctic marine mammals. Ecological Applications 18:77-96.

Born, E.W., F.F. Riget, R. Dietz, and D. Andriashek. 1999. Escape responses of hauled out ringed seals (Phoca hispida) to aircraft disturbance. Polar Biology. 21(3):171-178.

Braham, H.W., B.D. Krogman and G.M. Carroll. 1984. Bowhead and white whale migration, distribution, and abundance in the Bering, Chukchi, and Beaufort seas, 1975-78. NOAA Tech. Rep. NMFS SSRF-778. USDOC/NOAA/NMFS. NTIS PB84-157908. 39 p.

Brueggeman, J.J., C.I. Malme, R.A. Grotefendt, D.P. Volsen, J.J. Burns, D.G. Chapman, D.K. Ljungblad and G.A. Green. 1990. Shell Western E & P Inc. 1989 Walrus Monitoring Program: The Klondike, Burger, and Popcorn Prospects in the Chukchi Sea. Report prepared by EBASCO Environmental for Shell Western E & P Inc. 157 p.

Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers and L. Thomas. 2001. Introduction to distance sampling/Estimating abundance of biological populations. Oxford Univ. Press, Oxford, U.K. 432 p.

Burns, J.J. 1970. Remarks on the distribution and natural history of pagophilic pinnipeds in the Bering and Chukchi Seas. J. Mammal. 51(3):445-454.

Burns, J.J. 1981a. Ribbon seal—Phoca fasciata. Page 89-109 In S. H. Ridgway and R. J. Harrison (eds.), Handbook of marine mammals. Vol. 2. Seals. Academic Press, New York

Burns, J.J. 1981b. Bearded seal Erignathus barbatus Erxleben, 1777. p. 145-170 In: S.H. Ridgway and R.J. Harrison (eds.), Handbook of Marine Mammals, Vol. 2: Seals. Academic Press, New York.

Burns, J. J., and K.J. Frost. 1979. The natural history and ecology of the bearded seal, Erignathus barbatus. Environmental Assessment of the Alaskan Continental Shelf, Final Report (19). 311-392.

Burns, J. J., B. P. Kelly, L. D. Aumiller, K.J. Frost, and S. Hills. 1982. Studies of ringed seals in the Alaskan Beaufort Sea during winter: impacts of seismic exploration. Unpubl. annual report, OCSEAP Res. Unit, 232 p.

Cameron, M. and P. Boveng. 2009. Habitat Use and Seasonal Movements of Adult and Sub-Adult Bearded Seals. AFSC Quarterly Report, October November December 2009.

Cameron, M., P. Boveng, J. Goodwin, and A. Whiting. 2009. Seasonal movements, habitat selection, foraging and haul-out behavior of adult bearded seals. Poster Presentation: Bio. of Mar. Mam. 18th Biennial Conf., Soc. for Mar. Mamm., Quebec City, Canada, Oct 2009.

Cameron, M. F., J. L. Bengtson, P. L. Boveng, J. K. Jansen, B. P. Kelly, S. P. Dahle, E. A. Logerwell, J. E. Overland, C. L. Sabine, G. T. Waring, and J. M. Wilder. 2010. Status review of the bearded seal (Erignathus barbatus). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-211, 246 p.

Christie, K., C. Lyons, and W.R. Koski. 2010. Beaufort Sea aerial monitoring program. (Chapter 7) In: Funk, D.W, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-3, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 499 p. plus Appendices.

CITES. 2013. CITES Appendices. Available at http://www.cites.org/eng/app/appendices.php

Clarke, J., S. Moore, and D. Ljungblad. 1989. Observations of the gray whale (Eschrichtius robustus) utilization and patterns in the northeast Chukchi Sea, July-October 1982-1987. Can. J. Zool. 67:2646-2653.

Clarke, J.T., Ferguson, M.C., Christman, C.L., Grassia, S.L., Brower, A.A. and Morse, L.J. 2011. Chukchi Offshore Monitoring in Drilling Area (COMIDA) Distribution and Relative Abundance of Marine Mammals: Aerial Surveys. Final Report, OCS Study BOEMRE 2011-06. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Clarke, J.T., C.L. Christman, A.A. Brower, and M.C. Ferguson. 2012. Distribution and relative abundance of marine mammals in the Alaskan Chukchi and Beaufort seas, 2011. Annual Report, OCS Study BOEM 2012-09. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Clarke, J.T., C.L. Christman, A.A. Brower, and M.C. Ferguson. 2013. Distribution and relative abundance of marine mammals in the northeastern Chukchi and western Beaufort seas, 2012. Annual Report, OCS Study BOEM 2013-00117. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Clarke, J.T. and M.C. Ferguson. In prep. Distribution and relative density of large whales in the northeastern Chukchi Sea: similarities and differences between a 17-year data gap, 1982-1991 and 2008-2010.

COMIDA. 2009. Chukchi Offshore Monitoring in Drilling Area. National Marine Mammal Laboratory Cetacean Assessment and Ecology Program, Bowhead Whale Aerial Surveys: Preliminary Data. Available at: http://www.afsc.noaa.gov/NMML/cetacean/bwasp/flights_COMIDA_fy09.php

Crawford J.A., K.J. Frost, and L.T. Quakenbush. 2012. Different habitat use strategies by subadult and adult ringed seals (Phoca hispida) in the Bering and Chukchi seas. Polar Biology. 35 (2): 241-255.

Cummings, W.C. and D.V. Holliday. 1983. Preliminary measurements of sound attenuation by snow over a model seal lair. J. Acoust. Soc. Am. 74(Supplement1):S55.

Dahlheim, M.E. and J.E. Heyning. 1999. Killer whale Orcinus orca (Linnaeus, 1758). p. 281-322 In: S.H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 6: The Second Book of Dolphins and the Porpoises. Academic Press, San Diego, CA. 486 p.

DFO Canada. 2004. North Atlantic Right Whale. Fisheries and Oceans Canada. Available at http://www.mar.dfo-mpo.gc.ca/masaro/english/Species_Info/Right_Whale.html

Finley, K.J., G.W. Miller, R.A. Davis and W.R. Koski. 1983. A distinctive large breeding population of ringed seals (Phoca hispida) inhabiting the Baffin Bay pack ice. Arctic 36(2):162-173.

Forney, K.A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-1992. Mar. Mamm. Sci. 14(3) 460-489.

Frost, K. J., L. F. Lowry, and G. Carroll. 1993. Beluga whale and spotted seal use of a coastal lagoon system in the northeastern Chukchi Sea. Arctic 46:8-16.

Frost, K.J., L.F. Lowry, J.R. Gilbert, and J.J. Burns. 1988. Ringed seal monitoring: relationships of distribution and abundance to habitat attributes and industrial activities. Final Rep., contract no. 84-ABC-00210submitted to U.S. Dep. Interior, Minerals Management Service, Anchorage, AK. 101 pp.

Frost, K.J., L.F. Lowry, G. Pendleton, and H.R. Nute. 2004. Factors affecting the observed densities of ringed seals, Phoca hispida, in the Alaskan Beaufort Sea, 1996-99. Arctic 57(2):115-128.

Funk, D.W., C.M. Reiser, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2013. Joint Monitoring Program in the Chukchi and Beaufort seas, 2006–2010. LGL Alaska Final Report P1213-2, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 592 p. plus Appendices.

Gambell, R. 1985. Fin whale Balaenoptera physalus (Linnaeus, 1758). p. 171-192, In: S.H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 3: The Sirenians and Baleen Whales, Academic Press, London, U.K. 362 p.

George, J.C., L.M. Philo, K. Hazard, D. Withrow, G.M. Carroll, and R. Suydam. 1994. Frequency of killer whale (Orcincus orca) attacks and ship collisions based on scarring on bowhead whales (Balaena mysticetus) of the Bering-Chukchi-Beaufort Seas stock. Arctic 47(3):247-255.

Givens, G.H., S.L. Edmondson, J.C. George, R. Suydam, R.A. Charif, A. Rahaman, D. Hawthorne, B. Tudor, R.A. DeLong, and C.W. Clark. 2013. Estimate of 2011 abundance of the Bering-Chukchi-Beaufort seas bowhead whale population. Rep. Int. Whal. Comm., Paper SC/65a/BRG01. Cambridge, UK.

Greene, C.R., Jr., R.G. Norman, S.B. Blackwell, and A. Thode. 2007. Acoustics research for studying bowhead migration, 2006. Chapter 10 In D.S. Ireland, D.W. Funk, R. Rodrigues, and W.R. Koski (eds.). Joint monitoring program in the Chukchi and Beaufort Seas, July-November 2006, LGL Rep. P891-2. Prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, and LGL Ltd., environmental research associates, King City, Ont., for Shell Offshore Inc., ConocoPhillips Alaska, Inc., GX Technology, the National Marine Fisheries Service, and the U.S. Fish and Wildlife Service.

Green, G.A., K. Hashagen, and D. Lee. 2007. Marine mammal monitoring program, FEX barging project, 2007. Report prepared by Tetra Tech EC, Inc., Bothell WA, for FEX L.P., Anchorage, AK.

Greene, C.R., Jr., and S.E. Moore. 1995. Manmade noise, Chapter 6 in W.J. Richardson, C.R. Greene, Jr., C.I. Malme, and D.H. Thomson (eds.). Marine Mammals and Noise. Academic Press, San Diego, CA.

Hammill, M.O., C. Lydersen, M. Ryg, and T.G. Smith. 1991. Lactation in the ringed seal (Phoca hispida). Can. J. Fish. Aquatic Sci. 48(12):2471-2476.

Haley, B. 2006. Marine mammal monitoring during University of Texas at Austin's marine geophysical survey of the western Canada Basin, Chukchi Borderland and Mendeleev Ridge, Arctic Ocean, July–August 2006. Report from LGL Alaska Research Associates, Inc., Anchorage AK, and LGL Ltd., King City, Ont., for the University of Texas at Austin, the Nat. Mar. Fish. Serv., Silver Springs, MD, and the U.S. Fish and Wildl. Serv., Anchorage, AK.

Haley, B. and D. Ireland. 2006. Marine mammal monitoring during University of Alaska Fairbanks marine geophysical survey across the Arctic Ocean, August-September 2005. LGL Rep. TA4122-3. Rep. from LGL Ltd., King City, Ont., for Univ. Alaska Fairbanks, Fairbanks, AK, and Nat. Mar. Fish. Serv., Silver Spring, MD. 80 p.

Haley, B., J. Beland, D.S. Ireland, R. Rodrigues, and D.M. Savarese. 2010. Chukchi Sea vessel-based monitoring program, (Chapter 3) In: Funk, D.W, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-3, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research , Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 499 p. plus Appendices.

Hartin, K.G., C.M. Reiser, D.S. Ireland, R. Rodrigues, D.M.S. Dickson, J. Beland, and M. Bourdon. 2013. Chukchi Sea vessel-based monitoring program. (Chapter 3) In: Funk, D.W., C.M. Reiser, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2013. Joint Monitoring Program in the Chukchi and Beaufort seas, 2006–2010. LGL Alaska Final Report P1213-1, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 592 p. plus Appendices.

Harwood, J. and B. Wilson. 2001. The implications of developments on the Atlantic Frontier for marine mammals. Cont. Shelf Res. 21(8-10):1073-1093.

Harwood, L.A., F. McLaughlin, R.M. Allen, J. Illasiak Jr. and J. Alikamik. 2005. First-ever marine mammal and bird observations in the deep Canada Basin and Beaufort/Chukchi seas: expeditions during 2002. Polar Biol. 28(3):250-253.

Harwood, L., S. Innes, P. Norton and M. Kingsley. 1996. Distribution and abundance of beluga whales in the Mackenzie estuary, southeast Beaufort Sea, and the west Amundsen Gulf during late July 1992. Can. J. Fish. Aquatic Sci. 53(10):2262-2273.

Innes, S., M.P. Heide-Jørgensen, J. Laake, K. Laidre, H. Cleator and P. Richard. 2002. Surveys of belugas and narwhals in the Canadian high Arctic in 1996. NAMMCO Sci. Publ. 4:169-190.

IUCN (The World Conservation Union). 2013. Version 2013.1 Accessed 7 August 2013. 2013 IUCN Red List of Threatened Species. http://www.redlist.org

Jones, M.L. and S.L. Swartz. 1984. Demography and phenology of gray whales and evaluation of whale-watching activities in Laguna San Ignacio, Baja California Sur, Mexico. p. 309-374 In: M. L. Jones et al. (eds.), The Gray Whale Eschrichtius robustus. Academic Press, Orlando, FL. 600 p.

Kelly, B.P., L.T. Quakenbush and J.R. Rose. 1986. Ringed seal winter ecology and effects of noise disturbance. Outer Continental Shelf Environmental Assessment Program, Final Report. NOAA, Anchorage, AK: pp 447-536.

Kelly, B.P. 1988. Bearded seal, Erignathus barbatus. p. 77-94 In: J.W. Lentfer (ed.), Selected Marine Mammals of Alaska/Species Accounts with Research and Management Recommendations. Mar. Mamm. Comm., Washington, DC. 275 p.

King, J.E. 1983. Seals of the World, 2nd ed. Cornell Univ. Press, Ithaca, NY. 240 p.

Laake J., R. Hobbs, M. Ferguson, D. Rugh, J. Breiwick. 2009. Re-analysis of gray whale southbound migration surveys 1967-2006. NOAA Tech Memo NMFS-AFSC-203. US Department of Commerce, Seattle WA.

Leatherwood, S., A.E. Bowles, and R. Reeves. 1986. Aerial surveys of marine mammals in the southeastern Bering Sea. U.S. Department of Commerce, NOAA, OCSEAP Final Report 42:147-490.

LGL Alaska Research Associates, Inc., JASCO Applied Sciences, Inc., and Greeneridge Sciences, Inc. 2013. Joint Monitoring Program in the Chukchi and Beaufort Seas, 2012. LGL Alaska Draft Report P1272-2 for Shell Offshore, Inc. ION Geophysical, Inc., and Other Industry Contributors, National Marine Fisheries Service, and U.S. Fish and Wildlife Service. 320 p. plus Appendices.

LGL Alaska Research Associates, Inc. 2013. 2012 Alaskan Arctic Aerial Image Analysis. Anchorage, Alaska.

LGL Alaska Research Associates, Inc. and Industry Contributors. 2014. Background and context. (Chapter 2) In: LGL Alaska Research Associates, Inc., JASCO Applied Sciences, Inc., and Greeneridge Sciences, Inc. 2014. Joint Monitoring Program in the Chukchi and Beaufort Seas, 2012. LGL Alaska Final Report P1272-2 for Shell Offshore, Inc. ION Geophysical, Inc., and Other Industry Contributors, National Marine Fisheries Service, and U.S. Fish and Wildlife Service. 320 p. plus Appendices.

Ljungblad, D.K., S.E. Moore and D.R. Van Schoik. 1984. Aerial surveys of endangered whales in the Beaufort, eastern Chukchi, and northern Bering Seas, 1983: with a five year review, 1979-1983. NOSC Tech Rep. 955. Rep. from Naval Ocean Systems Center, San Diego, CA for U.S. Minerals Manage. Serv., Anchorage, AK. 356 p. NTIS AD-A146 373/6.

Lowry, L.F., K.J. Frost, and J.J. Burns. 1980. Variability of the diet of ringed seals, Phoca hispida, in Alaska. Can. J. Fish Aquat. Sci. 37:2254-2261.

Lowry, L.F., K.J. Frost, R. Davis, R.S. Suydam and D.P. DeMaster. 1994. Satellite-tagging of spotted seals (Phoca largha) at Kasegaluk Lagoon, Alaska, 1992-1993. OCS Study MMS 94-0067. Rep. from Alaska Dep. Fish & Game, Fairbanks, AK, for U.S. Minerals Manage. Serv., Anchorage, AK. 23 p.

Lowry, L.F., K.J. Frost, R. Davis, D.P. DeMaster, and R.S. Suydam. 1998. Movements and behavior of satellite-tagged spotted seals (Phoca largha) in the Bering and Chukchi Seas. Polar Biol. 19(4):221-230.

Lowry, L.F., R.R. Nelson, and K.J. Frost. 1987. Observations of killer whales, (Orcincus orca) in western Alaska: Sightings, strandings and predation on other marine mammals. Canadian Field-Naturalist 101:6-12.

Lydersen, C. and M.O. Hammill. 1993. Diving in ringed seal (Phoca hispida) pups during the nursing period. Can. J. Zool. 71(5):991-996.

Lyons, C., W. Koski, and D. Ireland. 2009. Chapter 7 in Ireland, D.S., D.W. Funk, R. Rodrigues, and W.R. Koski (eds.). 2009. Joint monitoring program in the Chukchi and Beaufort seas, July–November 2007. LGL Alaska Report P971-2. Report from LGL Alaska Research Associates, Inc., Anchorage, AK, LGL Ltd., environmental research associates, King City, Ont., JASCO Research, Victoria, B.C., and Greeneridge Sciences, Inc., Goleta, CA, for Shell Offshore, Inc., ConocoPhillips Alaska, Inc., the National Marine Fisheries Service, silver Springs, MD, and U.S. Fish and Wildlife Service, Anchorage, AK. 445 p. plus appendices.

MacIntyre, K.Q. and K.M. Stafford. 2011. Year-round passive acoustic monitoring of bearded seal vocalizations at three locations in the Beaufort Sea. Poster Presentation: Alaska Marine Science Symposium. Anchorage Alaska. January 2011.

Mallonee, J.S. 1991. Behavior of gray whales (Eschrichtius robustus) summering off the northern California coast, from Patrick's Point to Crescent City. Can. J. Zool. 69:681-690.

Miller, G.W., R.E. Elliot, T.A. Thomas, V.D. Moulton, and W.R. Koski. 2002. Distribution and numbers of bowhead whales in the eastern Alaskan Beaufort Sea during late summer and autumn, 1979-2000. Chapter 9 In Richardson, W.J. and D.H. Thomson (eds). 2002. Bowhead whale feeding in the eastern Alaskan Beaufort Sea: update of scientific and traditional information. OCS Study MMS 2002-012; LGL Rep. TA2196-7. Rep. from LGL Ltd., King City, Ont., for U.S. Minerals Manage. Serv., Anchorage, AK, and Herndon, VA. xliv + 697 p. 2 vol. NTIS PB2004-101568. Available from www.mms.gov/alaska/ref/AKPUBS.HTM#2002.

Monnett, C. and S.D. Treacy. 2005. Aerial surveys of endangered whales in the Beaufort Sea, fall 2002-2004. OCS Study MMS 2005-037. Minerals Manage. Serv., Anchorage, AK. xii + 153 p.

Moore, S.E. 2000. Variability in cetacean distribution and habitat selection in the Alaskan Arctic, autumn 1982-91. Arctic 53(4):448-460.

Moore, S.E. and R.R. Reeves. 1993. Distribution and movement. p. 313-386 In: J.J. Burns, J.J. Montague and C.J. Cowles (eds.), The Bowhead Whale. Spec. Publ. 2. Soc. Mar. Mammal., Lawrence, KS. 787 p.

Moore, S.E., J.M. Grebmeier and J.R. Davies. 2003. Gray whale distribution relative to forage habitat in the northern Bering Sea: current conditions and retrospective summary. Can. J. Zool. 81(4):734-742.

Moore, S.E., K.M. Stafford, D.K. Mellinger, and J.A. Hildebrand. 2006. Listening for large whales in the offshore waters of Alaska. BioScience. 56(1):49-55.

Moore, S.E., K.M. Stafford and L.M. Munger. 2010. Acoustic and visual surveys for bowhead whales in the western Beaufort and far northeastern Chukchi Seas. Deep-Sea Res. II 57(1-2):153-157.

Moulton, V.D. and J.W. Lawson. 2002. Seals, 2001. p. 3-1 to 3-46 In: W.J. Richardson and J.W. Lawson (eds.), Marine mammal monitoring of WesternGeco's open-water seismic program in the Alaskan Beaufort Sea, 2001. LGL Rep. TA2564-4. Rep. from LGL Ltd., King City, Ont., for WesternGeco LLC, Anchorage, AK; BP Explor. (Alaska) Inc., Anchorage, AK; and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD. 95 p.

Nerini, M. 1984. A review of gray whale feeding ecology. p. 423-450 In: M.L. Jones, S.L. Swartz and S. Leatherwood (eds.), The Gray Whale, Eschrichtius robustus. Academic Press, Inc. Orlando, FL. 600 p.

NMFS. 2001. Small takes of marine mammals' incidental to specified activities; oil and gas exploration drilling activities in the Beaufort Sea/Notice of issuance of an incidental harassment authorization. Fed. Regist. 66(26, 7 Feb.): 9291-9298.

NMFS. 2011. Takes of marine mammals' incidental to specified activities: taking marine mammals' incidental to polar bear captures. Fed. Regist. 76(47, 10 March):13130.

NMFS. 2012a. Endangered and threatened species; threatened status for the Arctic, Okhotsk, and Baltic subspecies of the ringed seal and Endangered Status for the Ladoga subspecies of the ringed seal. Fed. Regist. 77(249, 28 Dec.):76706-76738.

NMFS. 2012b. Endangered and threatened species; threatened status for the Beringia and Okhotsk distinct population segments of the *Erignathus barbatus nauticus* subspecies of the bearded seal. Fed. Regist. 77(249, 18 Dec.):76740-76768.

NMML. 2009. Telemetry of ice seals captured during a research cruise aboard the McArthur II in the Eastern Bering Sea, Quarterly Report. http://www.afsc.noaa.gov/Quarterly/amj2009/divrptsNMML3.htm

O'Corry-Crowe, G.M., R.S. Suydam, A. Rosenberg, K.J. Frost and A.E. Dizon. 1997. Phylogeography, population structure and dispersal patterns of the beluga whale Delphinapterus leucas in the western Nearctic revealed by mitochondrial DNA. Molec. Ecol. 6(10):955-970.

Patenaude, N.J., W.J. Richardson, M.A. Smultea, W.R. Koski, and G.W. Miller. 2002. Aircraft sound and disturbance to bowhead and beluga whales during spring migration in the Alaskan Beaufort Sea. Marine Mammal Science 18(2):309–335.

Patterson, H., S.B. Blackwell, B. Haley, A. Hunter, M. Jankowski, R. Rodrigues, D. Ireland and D.W. Funk. 2007. Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–September 2006: 90–day report. LGL Draft Rep. P891–1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Goleta, CA, for Shell Offshore Inc, Houston, TX, and Nat. Mar. Fish. Serv., Silver Springs, MD. 199 p.

Popov, L. A. 1976. Status of main ice forms of seals inhabiting waters of the U.S.S.R. and adjacent to the country marine areas. FAO ACMRR/MM/SC/51. 17 pp.

Quakenbush, L.T. 1988. Spotted seal, Phoca largha. p. 107-124 In: J.W. Lentfer (ed.), Selected Marine Mammals of Alaska/Species Accounts with Research and Management Recommendations. Marine Mammal Comm., Washington, DC. 275 p.

Read, A.J. 1999. Harbour porpoise Phocoena phocoena (Linnaeus, 1758). p. 323-355 In: S.H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals. Vol. 6: The Second Book of Dolphins and the Porpoises. Academic Press, San Diego, CA. 486 p.

Reeves, R.R. 1980. Spitsbergen bowhead stock: a short review. Mar. Fish. Rev. 42(9/10):65-69.

Reeves, R.R., B.S. Stewart, P.J. Clapham and J.A. Powell. 2002. Guide to Marine Mammals of the World. Chanticleer Press, New York, NY.

Reider, H.J., L.N. Bisson, M. Austin, A. McCrodan. J. Wladichuk, C.M. Reiser, K.B. Matthews, J.R. Brandon, K. Leonard, and H.M. Patterson. 2013. Marine mammal monitoring and mitigation during Shell's activities in the Chukchi Sea, July–September 2013: Draft 90-Day Report. LGL Report P1272D–2. Report from LGL Alaska Research Associates Inc., Anchorage, AK, USA, and JASCO Applied Sciences, Victoria, BC, Canada, for Shell Gulf of Mexico, Houston, TX, USA, National Marine Fisheries Service, Silver Spring, MD, USA, and U.S. Fish and Wildlife Service, Anchorage, AK, USA. 198 pp, plus appendices.

Rice, D.W. and A.A. Wolman. 1971. The life history and ecology of the gray whale (Eschrichtius robustus). Am. Soc. Mamm. Spec. Publ. 3:142 p.

Richardson, W.J., M.A. Fraker, B. Wursig, and R.S. Wells. 1985a. Behavior of Bowhead Whales, Balaena Mysticetus, summering in the Beaufort Sea: reactions to industrial activities. Biological Conservation. 32(3):195-230.

Richardson, W.J., R.S. Wells, and B. Wursig. 1985b. Disturbance responses of Bowheads, 1980-1984. in: Behavior, disturbance responses, and distribution of bowhead whales, Balaena mysticetus, in the Eastern Beaufort Sea, 1980-84, W.J. Richardson, ed. OCS Study MMS 85-0034. Anchorage, AK: USDOI, MMS, Alaska OCS Region, pp. 255-306.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme and D.H. Thomson. 1995a. Marine Mammals and Noise. Academic Press, San Diego. 576 p.

Rugh, D.J., K.E.W. Sheldon, D.E. Withrow, H.W. Braham, and R.P Angliss. 1993. Spotted seal summer distribution and abundance in Alaska. In: Abstr. 10th Bienn. Conf. Biol. Mar. Mamm., Galveston, TX, Nov. 1993.

Rugh, D.J., K.E.W. Shelden and D.E. Withrow. 1997. Spotted seals, Phoca largha, in Alaska. Mar. Fish. Rev. 59(1):1-18.

Savarese, D.M., C.R. Reiser, D.S. Ireland, and R. Rodrigues. 2010. Beaufort Sea vessel-based monitoring program. (Chapter 6) In: Funk, D.W, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-3, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research , Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 499 p. plus Appendices.

Shaughnessy, P.D. and F.H. Fay. 1977. A review of the taxonomy and nomenclature of North Pacific harbor seals. J. Zool. (Lond.) 182:385-419.

Smith, T.G. 1973. Population dynamics of the ringed seal in the Canadian eastern arctic. Fish. Res. Board Can. Bull. 181:55 p.

Smith, T.G. and I. Stirling. 1975. The breeding habitat of the ringed seal (Phoca hispida): the birth lair and associated structures. Can. J. Zool. 53(9):1297-1305.

Stafford, K.M., S.E. Moore, M. Spillane, S. Wiggins. 2007. Gray whale calls recorded near Barrow, Alaska, throughout the winter of 2003-04. Arctic 60(2): 167-172.

Stewart, B.S. and S. Leatherwood. 1985. Minke whale Balaenoptera acutorostrata Lacépède, 1804. p. 91-136 In: S.H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 3: The Sirenians and Baleen Whales. Academic Press, London, U.K. 362 p.

Stirling, I., M. Kingsley and W. Calvert. 1982. The distribution and abundance of seals in the eastern Beaufort Sea, 1974-79. Can. Wildl. Serv. Occas. Pap. 47:25 p.

Suydam, R.S. and J.C. George. 1992. Recent sightings of harbor porpoises, Phocoena phocoena, near Point Barrow, Alaska. Can. Field-Nat. 106(4): 489-492.

Suydam, R.S., L.F. Lowry, and K.J. Frost. 2005. Distribution and movements of beluga whales from the eastern Chukchi Sea stock during summer and early autumn. OCS Study MMS 2005-035. 35 p.

Swartz, S.L. and M.L. Jones. 1981. Demographic studies and habitat assessment of gray whales, Eschrichtius robustus, in Laguna San Ignacio, Baja California, Mexico. U.S. Mar. Mamm. Comm. Rep. MMC-78/03. 34 p. NTIS PB-289737.

Tomilin, A.G. 1957. Mammals of the U.S.S.R. and adjacent countries, Vol. 9: Cetaceans. Israel Progr. Sci. Transl. (1967), Jerusalem. 717 p. NTIS TT 65-50086.

Urick, R.J. 1972. Noise signature of an aircraft in level flight over a hydrophone in the sea. J. Acoustic Soc. Am. 52(3, Pt. 2):993-999. In: Richardson, W.J., C.R. Greene, Jr., C.I. Malme and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576 p.

Zeh, J.E. and A.E. Punt. 2005. Updated 1978-2001 abundance estimates and their correlations for the Bering-Chukchi-Beaufort Seas stock of bowhead whales. J. Cetac. Res. Manage. 7(2):169-175.

Attachment A
Chukchi and Beaufort Sea Ice Overflight Survey Program
Marine Mammal Monitoring and Mitigation Plan (4MP)

Attachment B
Chukchi Sea Plan of Cooperation (POC)